

FINAL REPORT SUBMITTED TO
DR. ANN ACHESON
NORTHERN REGION
U.S. DEPARTMENT OF AGRICULTURE
U.S. FOREST SERVICE

REGARDING:

ESTABLISHMENT OF A LICHEN BIOMONITORING PROGRAM AND
AIR QUALITY BASELINE IN AND NEAR THE SELWAY-BITTERROOT
WILDERNESS AREA

COPY

PREPARED & SUBMITTED
BY

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31 DECEMBER 1995

INTRODUCTION

PROJECT OBJECTIVES:

1. Locate and establish 15 air quality bimonitoring reference sites within and near the Selway Bitterroot Wilderness Area.
2. Collect, curate, and identify lichen species from various habitats and substrates at each reference site.
3. Identify 3-5 pollution-sensitive lichen species at each reference site. Collect enough tissue of at least one sensitive indicator species (approximately 6-10 grams dry weight) from each reference site for elemental analyses. Rare species will not be sampled for analysis, but their distribution will be noted.
4. Determine baseline thallus concentrations of 20 potential pollutant elements (including sulfur, selenium, arsenic, copper, bromine, manganese, lead, vanadium, potassium, iron, etc.), using replicate samples of one documented pollution-sensitive species collected at each reference site. Samples will be analyzed using Proton Induced X-ray Emission (PIXE) techniques.
5. Prepare and submit a draft report by 31 May 1995.
6. Prepare and submit a final report details by 31 December 1995.

LICHENS AS BIOLOGICAL INDICATORS OF AIR QUALITY:

Protocol for using lichens as bioindicators of air quality is well-documented (Fields & St.Clair 1984; St.Clair 1989; Richardson 1992). Hale (1983) noted that lichens have been used in three basic ways to monitor the effects of air pollution on biological systems: 1) elemental analysis of lichen tissues, 2) mapping of all (or selected) lichen species found in areas adjacent to pollution sources, and 3) transplant studies. Currently, the most common approach involves a floristic survey along with elemental analyses of tissues from sensitive indicator species (St.Clair 1989; Wetmore 1989).

As lichens accumulate many different pollutants from atmospheric outwash, lichen tissues provide a record of the kinds and relative quantities of air pollutants in any particular airshed (Schutte 1977; Wetmore 1989; Rope & Pearson 1990). Pollutant accumulation patterns for specific elements have been monitored over time by correlating thallus growth rates and pollutant concentrations in excised portions of lichen thalli (Lawry & Hale 1981). Changes in lichen physiological processes indicate pollution-related damage long before other, more easily detectable changes in thallus color, morphology, or community structure become apparent (Fields & St.Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Rushforth et al. 1982; Wetmore 1989). As certain lichen species are inherently more sensitive to airborne contaminants, air quality can be effectively monitored by occasionally reevaluating lichen community and/or physiological parameters. Pollution-related changes can then be documented by comparing follow-up data to original baseline data.

GENERAL HABITAT DESCRIPTION FOR THE SELWAY-BITTERROOT WILDERNESS AREA:

The Selway-Bitterroot Wilderness Area consists of 1,337,681 acres. The wilderness is administered by the Bitterroot, Lolo, Nez Perce, and Clearwater national forests of the U.S. Forest Service. An additional 132,078 acres of unroaded canyons along the east face of the Bitterroots brings the total contiguous acres in this wildland area to 1,469,759 acres. The eastern boundary of the wilderness stretches for approximately 90 miles from Lolo Creek on the north to Nez Perce Pass on the south. The east face of the Bitterroot Range is broken by more than 30 significant drainages and marks the eastern boundary of the Idaho batholith. The northern end of the range consists of metamorphic rocks while the peaks from Stevensville south are granitic. The classic U-shaped, east-west canyons, hanging valleys, subalpine lake basins and sheer cliffs are reminders of the extensive Pleistocene glaciation which shaped the rugged terrain of the Bitterroot Mountains.

Steep elevational gradients compounded by the complicated topography of the wilderness has resulted in the development of a significant number of habitat types ranging from alpine tundra and krummholz at the higher elevations to subalpine coniferous forests and riparian communities downslope.

LICHEN BIOMONITORING REFERENCE SITES IN THE SELWAY-BITTERROOT WILDERNESS AREA:

A total of 15 air quality biomonitoring reference sites have been established in and near the Selway-Bitterroot Wilderness Area (figure 1). Below is a detailed description of the air quality biomonitoring reference sites established within and near the Selway-Bitterroot Wilderness Area between 1992 and 1994:

SITE #1: 21 July 1992. Montana, Ravalli County, Bitterroot National Forest, Selway Bitterroot Wilderness Area: Lost Horse Canyon-Bear Creek Pass. 46° 7' 12" north latitude; 114° 29' 38" west longitude. Elevation 2100 m (6889 feet).

SITE #2: 21 July 1992. Montana, Ravalli County, Bitterroot National Forest: Lost Horse Canyon-vicinity of Tenmile Creek. 46° 8' 34" north latitude; 114° 24' 38" west longitude. Elevation 1700 m (5577 feet).

SITE #3: 21 July 1992. Montana, Ravalli County, Bitterroot National Forest: Lost Horse Canyon-vicinity of South Fork of Lost Horse Creek. 46° 6' 41" north latitude; 114° 17' 4" west longitude. Elevation 1350 m (4429 feet).

SITE #4: 23 July 1992. Montana, Ravalli County, Bitterroot National Forest, Selway Bitterroot Wilderness Area: vicinity of Nez Perce Pass. 45° 43' 27" north latitude; 114° 30' 22" west longitude. Elevation 2000 m (6562 feet).

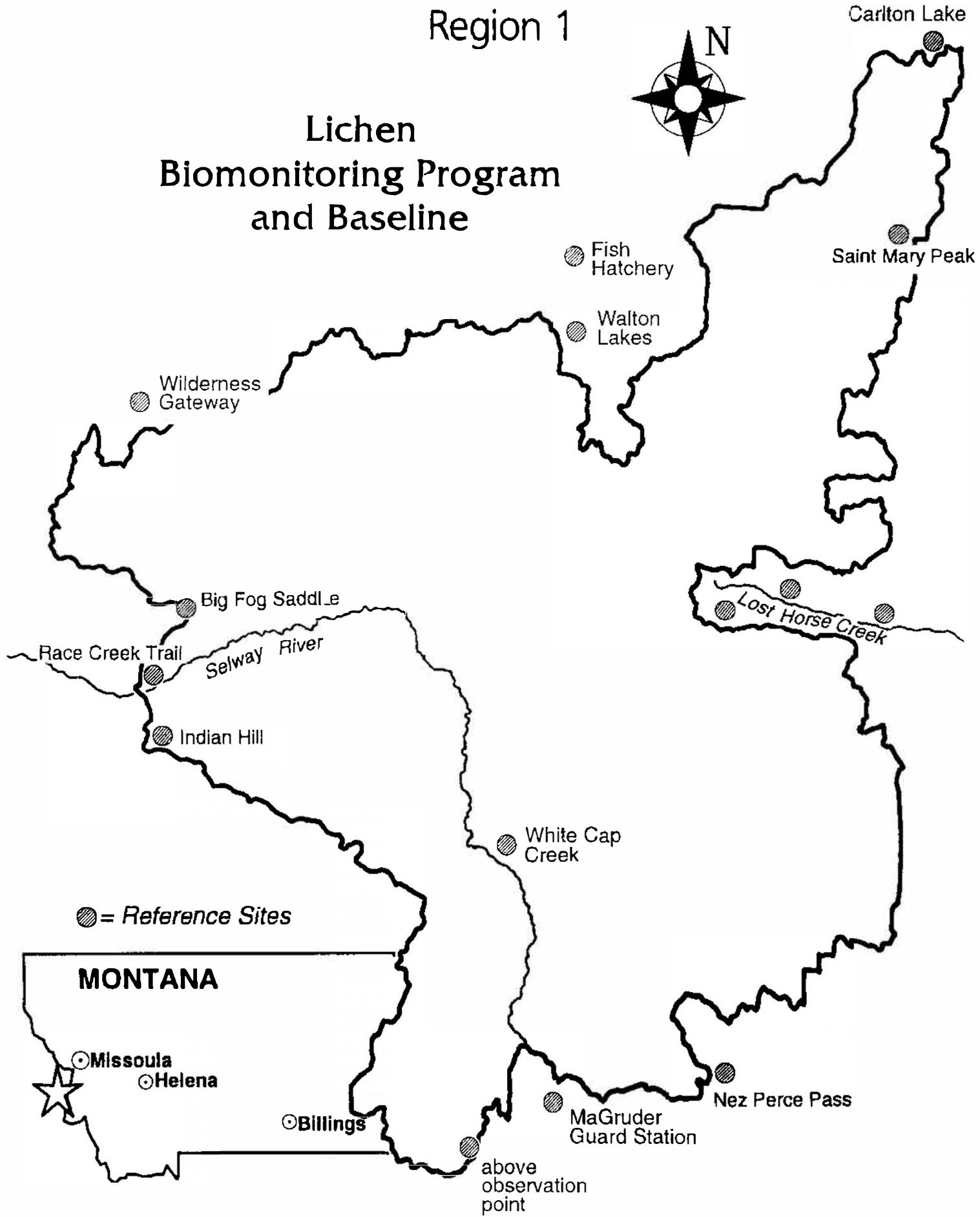
SITE #5: 22 July 1992. Montana, Missoula County, Bitterroot National Forest, Selway Bitterroot Wilderness Area: vicinity of Carlton Ridge. 46° 40' 38" north latitude; 114° 12' 41" west longitude. Elevation 2250 m (7381 feet).

SITE #6: 24 July 1992. Montana, Ravalli County, Bitterroot National Forest, Selway Bitterroot Wilderness Area: St. Mary's Peak. 46° 30' 57" north latitude; 114° 14' 31" west longitude. Elevation 2750 m (9022 feet).

SELWAY BITTERROOT WILDERNESS AREA

Region 1

Lichen Biomonitoring Program and Baseline



SITE #7: 27 July 1993. Idaho, Idaho County, Nez Perce National Forest, Selway Bitterroot Wilderness Area: Race Creek Trail (U.S. Forest Service Trail 4) along Selway River. 46° north latitude; 115° 15' west longitude. Elevation 550 m (1804 feet).

SITE #8: 28 July 1993. Idaho, Idaho County, Nez Perce National Forest, Selway Bitterroot Wilderness Area: Indian Hill Trail. 46° north latitude; 115° 15' west longitude. Elevation 2076 m (6810 feet).

SITE #9: 29 July 1993. Idaho, Idaho County, Nez Perce National Forest, Selway Bitterroot Wilderness Area: U.S. Forest Service Trail #693, along northeast-facing slope to Fog Mountain Saddle. 46° 7' north latitude; 115° 12' west longitude. Elevation 1828 m (6000 feet).

SITE #10: 12 July 1994. Idaho, Idaho County, Bitterroot National Forest, Selway Bitterroot Wilderness Area: along White Cap Creek Trail (U.S. Forest Service Trail #24). GPS reading: 45° 52.035' north latitude; 114° 43.818' west longitude. Elevation: 914 m (3000 feet).

SITE #11: 13 July 1994. Idaho, Idaho County, Frank Church River of No Return Wilderness Area, MaGruder Guard Station Trail (U.S. Forest Service Trail #4), along Selway River. GPS reading: 45° 42.129' north latitude; 114° 42.887' west longitude. Elevation: 1200 m (3937 feet).

SITE #12: 14 July 1994. Idaho, Idaho County, Frank Church River of No Return -Selway Bitterroot wilderness areas, along U.S. Forest Service Road #468, half way between "Observation Point" and Salmon Base Camp. GPS reading: 45° 39.558' north latitude; 114° 48.950' west longitude. Elevation: 2377 m (7800 feet). Specimens were also collected 1.7 km below MaGruder Massacre Trailhead (U.S. Forest Service Trail #7), along U.S. Forest Service Road #468. GPS reading: 45° 40.620' north latitude; 114° 47.486' west longitude. Elevation: 1951 m (6400 feet).

SITE #13: 15 July 1994. Idaho, Idaho County, Clearwater National Forest, vicinity of Walton Lakes along U.S. Forest Service Trail #79. GPS reading: 46° 26.416' north latitude; 114° 42.741' west longitude. Elevation: 1920 m (6300 feet).

SITE #14: 16 July 1994. Idaho, Idaho County, Clearwater National Forest, vicinity of Wilderness Gateway, U.S. Forest Service Trail #211, along Boulder Creek. GPS reading: 46° 20.117' north latitude; 115° 18.869' west longitude. Elevation: 640 m (2100 feet). Specimens were also collected at Eagle Mountain Trailhead, along the Lochsa River. GPS reading: 46° 25.765' north latitude; 115° 08.018' west longitude. Elevation: 732 m (2400 feet).

SITE #15: 17 July 1994. Idaho, Idaho County, Clearwater National Forest, along U.S. Forest Service Road #362, south of fish hatchery, in "old growth" conifer stand. GPS reading: 46° 30.391' north latitude; 114° 40.868' west longitude. Elevation: 1128 m (3700 feet).

METHODS

COLLECTION, CURATION, IDENTIFICATION, AND DEPOSITION OF LICHEN SPECIES:

Because lichen distribution is directly influenced by substrate, moisture and sunlight, all available substrates and habitats at each reference site were carefully examined.

Small amounts of each lichen species were either removed directly from the substrate, or depending on the species, with a small piece of the substrate (bark, wood, soil, or rock).

All specimens were placed in carefully labeled paper sacks and taken back to the BYU Herbarium of Nonvascular Cryptogams, where they were curated, identified, placed in permanent herbarium packets, and labeled with the current epithets and authors' names as well as detailed information about the collection site, habitat, and substrate. Herbarium numbers (BRY C-) were also assigned.

Species were identified using standard lichen keys and taxonomic treatises. Standard chemical spot tests and, where necessary, thin-layer chromatography techniques were used to finalize species identifications.

One set of specimens will be permanently housed at the BYU Herbarium of Nonvascular Cryptogams in Provo, Utah. A second set of voucher specimens will be sent to any herbarium designated by the Forest Service.

COLLECTION OF LICHEN THALLI FOR LABORATORY ANALYSES:

After careful consideration of species abundance, substrate, growth form, documented/suspected pollution sensitivity and general distribution patterns of the lichens at each reference site, one or more species were designated sensitive indicator species and used for all laboratory chemical analyses.

At each reference site sufficient material of at least one sensitive, indicator species was collected for laboratory analyses (6-10 grams dry weight). All lichen material collected for elemental analyses was placed in Hubco cloth bags (to avoid contamination) and transported back to the BYU Herbarium of Nonvascular Cryptogams.

Excess material is permanently stored in Hubco cloth bags in the elemental analysis collection at the BYU Herbarium of Nonvascular Cryptogams. This material is available for additional testing upon request.

DETERMINATION OF ELEMENTAL CONCENTRATIONS IN LICHEN TISSUES:

In the laboratory, surface debris and dust were removed from all samples. Clean, two gram samples of at least one indicator species from each reference site were delivered to the Elemental Analysis Laboratory at Brigham Young University.

Samples were prepared for PIXE analysis using the methods of Duflou et al. (1987). Lichen samples were placed in Teflon containers with a teflon coated steel ball, cooled to liquid nitrogen temperature, powdered by brittle fracture using a Braun Mikro-Dismemberator II, and then dried in an Imperial IV Microprocessor Oven for 14 hours at 80°C. Subsamples weighing 150 mg were then weighed into teflon containers and spiked with 1 ml pf a 360 ppm yttrium solution. Samples were then oven dried again for 14 hours at 80°C; and homogenized again using the micro-dismemberator. Approximately 1 mg of the powdered lichen was then weighed onto a thin polycarbonate film in an area of 0.5cm². A 1.5% solution of polystyrene in toluene was used to secure the sample to the film.

Samples were analyzed using a 2 MV Van de Graaff accelerator with a 2.28 MeV proton beam which passed through a 1.1 mg/cm² pyrolytic graphite diffuser foil. The proton beam was collimated to irradiate an area of 0.38 cm² on the sample. Typically, 10-100 nA proton beam currents were used. X-rays were detected using a Tracor x-ray spectrometer, model TX-3/48-206, with a 10 mm² by 3 mm thick Si(Li) detector positioned at 90° to the proton beam. Samples were analyzed twice using different X-ray absorbers between the samples and the detector. One was a 49 mg/cm² Mylar absorber

Bryoria fremontii (Tuck.) Brodo & D. Hawksw.

Growth form: Fruticose

Substrate: White Bark Pine, River Hawthorn, Spruce, Amelanchier sp., Lodgepole Pine, Subalpine Fir, Douglas Fir, Ponderosa Pine, Engelmann Spruce, lignum, Larix occidentalis, Alnus sp.

Site(s): Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek, 8 km east of Bear Creek Pass, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes, along MaGruder Guard Station Trail, along U.S.F.S. Road #468, vicinity of Fish Hatchery

Relative abundance: locally common to abundant

Pollution sensitivity: sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23320, BRY C-23394, BRY C-23457, BRY C-23458, BRY C-23459, BRY C-23460, BRY C-23461, BRY C-26277, BRY C-26290, BRY C-26342, BRY C-26380, BRY C-26382, BRY C-26392, BRY C-26394, BRY C-26439a, BRY C-26447, BRY C-26478, BRY C-26626, BRY C-28667, BRY C-28673, BRY C-28686, BRY C-28982, BRY C-29004

Bryoria fuscescens (Gyelnik) Brodo & D. Hawksw.

Growth form: Fruticose

Substrate: Subalpine Fir, lignum, River Hawthorn, Douglas Fir, Ponderosa Pine, Thuja plicata, Engelmann Spruce

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, Race Creek Trail, vicinity of Fog Mountain Saddle, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23395, BRY C-23396, BRY C-23462, BRY C-23463, BRY C-26439a, BRY C-26448, BRY C-26460, BRY C-26472, BRY C-26605, BRY C-28615, BRY C-28651, BRY C-28974

Bryoria nitidula (Th. Fr.) Brodo & D Hawksw.

Growth form: Fruticose

Substrate: soil, detritus

Site(s): St. Mary's Peak

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21854

Buellia erubescens Arnold

Growth form: Crustose

Substrate: lignum

Site(s): South Fork Lost Horse Creek

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23464

Calicium viride Pers.

Growth form: Crustose

Substrate: Douglas Fir, *Thuja plicata*

Site(s): South Fork Lost Horse Canyon, Race Creek Trail, vicinity of White Cap Creek Trail, along MaGruder Guard Station Trail

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987); sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23465, BRY C-26332, BRY C-26519, BRY C-26539, BRY C-28561

Caloplaca cinnamomea (Th. Fr.) H. Olivier

Growth form: Crustose to obsolete

Substrate: detritus

Site(s): St. Mary's Peak

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21881, BRY C-21859

Caloplaca decipiens (Arnold) Blomb. & Forss.

Growth form: Crustose with effigurate margins

Substrate: rock

Site(s): South Fork Lost Horse Creek

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23466

Caloplaca epithallina Lyng

Growth form: Crustose to obsolete

Substrate: Epiphytic on other lichens

Site(s): St. Mary's Peak

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-22063

Caloplaca fraudans (Th. Fr.) H. Olivier

Growth form: Crustose to obsolete

Substrate: rock

Site(s): Carlton Ridge

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23397

Caloplaca jungermanniae (Vahl) Th. Fr.

Growth form: Crustose to obsolete
Substrate: soil, detritus
Site(s): Carlton Ridge
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23398

Caloplaca livida (Hepp) Jatta

Growth form: Crustose
Substrate: soil, detritus
Site(s): Carlton Ridge
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23399

Caloplaca tirolensis Zahlbr.

Growth form: Crustose to obsolete
Substrate: detritus
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21882

Candelaria concolor (Dickson) B. Stein

Growth Form: Minutely Foliose
Substrate: Douglas Fir
Site(s): Race Creek Trail
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28612

Candelariella placodizans (Nyl.) Magnusson

Growth form: Crustose
Substrate: detritus
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21834

Catapyrenium cinereum (Pers.) Körber

Growth form: Squamulose
Substrate: soil over rock
Site(s): Nez Perce Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23321

Cetraria hepatizon (Ach.) Vainio

Growth form: Foliose
Substrate: rock
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21869

Cetraria islandica (L.) Ach.

Growth form: Foliose
Substrate: soil
Site(s): Carlton Ridge
Relative abundance: locally abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23400

Cetraria nivalis (L.) Ach.

Growth form: Foliose
Substrate: soil, detritus
Site(s): St. Mary's Peak
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21853

Chrysothrix chlorina (Ach.) Laundon

Growth form: Crustose-leprose
Substrate: rock
Site(s): Race Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28540

Cladonia bacillaris Nyl.

Growth form: Squamulose (with podetia)
Substrate: soil, decomposing wood
Site(s): vicinity of White Cap Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26297, BRY C-26529

Cladonia bellidiflora (Ach.) Schaeerer

Growth form: Squamulose (with podetia)
Substrate: moss over wood, Ponderosa Pine, burned wood
Site(s): Race Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26498, BRY C-28629, BRY C-28655

Cladonia cariosa (Ach.) Sprengel

Growth form: Squamulose (with podetia)

Substrate: soil, moss over soil

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, vicinity of Fog Mountain Saddle, vicinity of White Cap Creek Trail, vicinity of Fish Hatchery

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23322, BRY C-23467, BRY C-26317, BRY C-26712, BRY C-29001

Cladonia carneola (Fr.) Fr.

Growth form: Squamulose (with podetia)

Substrate: decomposing wood

Site(s): Wilderness Gateway-Eagle Mountain Trailhead

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26489

Cladonia cervicornis (Ach.) Flotow subsp. *verticillata* (Hoffm.) Ahti

Growth form: Squamulose (with podetia)

Substrate: soil

Site(s): vicinity of Walton Lakes

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26558

Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel

Growth form: Squamulose (with podetia)

Substrate: detritus over soil, lignum, moss over rock, soil over rock, decomposing wood, humic soil

Site(s): Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek, vicinity of Tenmile Creek, Race Creek Trail, vicinity of Fog Mountain Saddle, vicinity of Walton Lakes, along MaGruder Guard Station Trail

Relative abundance: locally common to abundant

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23323, BRY C-23324, BRY C-23401, BRY C-23468, BRY C-23469, BRY C-23470, BRY C-26348, BRY C-26349, BRY C-26443, BRY C-28563, BRY C-28574, BRY C-29003

Cladonia coniocraea (Flörke) Sprengel

Growth form: Squamulose (with podetia)

Substrate: detritus, lignum, soil over rock, decomposing wood, moss over soil

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23325, BRY C-23471, BRY C-23472, BRY C-26367, BRY C-26488, BRY C-26705, BRY C-26707

Cladonia cornuta (L.) Hoffm. *subsp. cornuta*

Growth form: Squamulose (with podetia)

Substrate: moss over rock

Site(s): Race Creek Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28556

Cladonia deformis (L.) Hoffm.

Growth form: Squamulose (with podetia)

Substrate: detritus, lignum, decomposing wood, humic soil

Site(s): Nez Perce Pass, Carlton Ridge, vicinity of Walton Lakes, along U.S.F.S.

Road #468

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23326, BRY C-23327,
BRY C-23402, BRY C-26372, BRY C-26557

Cladonia cinnocyna Leighton

Growth form: Squamulose (with podetia)

Substrate: soil, humic soil

Site(s): vicinity of Walton Lakes, along U.S.F.S. Road #468

Relative abundance: common to abundant

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26371, BRY C-26398,
BRY C-26399, BRY C-26561

Cladonia fimbriata (L.) Fr.

Growth form: Squamulose (with podetia)

Substrate: detritus, lignum, soil over rock, moss over rock, moss over wood, humic soil, moss over soil

Site(s): Nez Perce Pass, Carlton Ridge, Bear Creek Pass, vicinity of Tenmile Creek, Race Creek Trail, vicinity of Fog Mountain Saddle, vicinity of White Cap Creek Trail, vicinity of Walton Lakes, along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: locally common

Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Wetmore 1987)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23328, BRY C-23329,
BRY C-23403, BRY C-23473, BRY C-23474, BRY C-23475, BRY C-26296,
BRY C-26304, BRY C-26319, BRY C-26351, BRY C-26434, BRY C-26709,
BRY C-26720, BRY C-28555, BRY C-29002

Cladonia gracilis (L.) Willd.

Growth form: Squamulose (with podetia)
Substrate: detritus, soil, soil over rock
Site(s): Nez Perce Pass, Vicinity of Tenmile Creek, Bear Creek Pass
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23330, BRY C-23476,
BRY C-23477

Cladonia macilenta Hoffm.

Growth form: Squamulose (with podetia)
Substrate: Ponderosa Pine
Site(s): Race Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28656

Cladonia macrophyllodes Nyl.

Growth form: Squamulose (with podetia)
Substrate: soil over rock
Site(s): Bear Creek Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23478

Cladonia multiformis G. K. Merr.

Growth form: Squamulose (with podetia)
Substrate: soil, moss over rock, detritus, moss over soil
Site(s): vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain
Trailhead, along MaGruder Guard Station Trail, vicinity of Fish Hatchery
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26318, BRY C-26364, BRY C-
26451, BRY C-26610, BRY C-26613, BRY C-26701, BRY C-26710, BRY C-
26714, BRY C-26718

Cladonia pocillum (Ach.) O.Rich

Growth form: Squamulose (with podetia)
Substrate: soil
Site(s): St. Mary's Peak, Carlton Ridge, along U.S.F.S. Road #468
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23404, BRY C-26378

Cladonia pyxidata (L.) Hoffm.

Growth form: Squamulose (with podetia)

Substrate: Selaginella sp., moss over rock, soil, humic soil

Site(s): Race Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes, along U.S.F.S. Road #468

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26376, BRY C-26400, BRY C-26555, BRY C-26596, BRY C-28573

Cladonia squamosa (Scop.) Hoffm.

Growth form: Squamulose (with podetia)

Substrate: Douglas Fir

Site(s): vicinity of Fish Hatchery

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26625

Cladonia stricta (Nyl.) Nyl.

Growth form: Squamulose (with podetia)

Substrate: soil, soil over rock, Lodgepole Pine, humic soil

Site(s): Carlton Ridge, Bear Creek Pass, vicinity of Walton Lakes, along U.S.F.S. Road #468

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23405, BRY C-23479, BRY C-26403, BRY C-26559

Cladonia subulata (L.) Weber ex Wigg.

Growth form: Squamulose (with podetia)

Substrate: detritus

Site(s): Nez Perce Pass

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23331

Cladonia sulphurina (Michaux) Fr.

Growth form: Squamulose (with podetia)

Substrate: detritus, lignum, soil, moss over wood, Ponderosa Pine, decomposing wood, burned lignum

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, Race Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail, along U.S.F.S. Road #468

Relative abundance: common to abundant

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23332, BRY C-23333,

BRY C-23480, BRY C-26324, BRY C-26325, BRY C-26326, BRY C-26404,

BRY C-26453, BRY C-26495, BRY C-26496, BRY C-26523, BRY C-28628,

BRY C-28654

Coelocaulon aculeatum (Schreber) Link

Growth form: Fruticose

Substrate: soil, detritus

Site(s): St. Mary's Peak

Relative abundance: locally abundant

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21852, BRY C-21789

Collema fuscovirens (With.) Laundon

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): vicinity of Walton Lakes

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26562

Cyphelium inquinans (Sm. in Sm. & Sow.) Trevisan

Growth form: Crustose

Substrate: lignum

Site(s): Race Creek Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28639

Cystocoleus ebeneus (Dillwyn) Thwaites

Growth form: Minutely fruticose

Substrate: moss over rock

Site(s): along MaGruder Guard Station Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26577

Dermatocarpon miniatum (L.) Mann

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Nez Perce Pass, Wilderness Gateway-Eagle Mountain Trailhead, along U.S.F.S. Road #468

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23334, BRY C-26405, BRY C-26604

Dermatocarpon reticulatum Magnusson

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Race Creek Trail, vicinity of Walton Lakes, along MaGruder Guard Station Trail, along U.S.F.S. Road #468

Relative abundance: common to abundant (especially abundant along flood zone of Selway River)

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23002, BRY C-26543, BRY C-26569, BRY C-26571

Dermatocarpon rivulorum (Arnold) Dalla Torre & Sarnth.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): vicinity of Walton Lakes

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26580

Diploschistes scruposus (Schreber) Norman

Growth form: Crustose

Substrate: rock

Site(s): Bear Creek Pass

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23481

Endocarpon pusillum Hedwig

Growth form: Squamulose

Substrate: soil

Site(s): St. Mary's Peak

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21874

Esslingeriana idahoensis (Essl.) Hale & Lai

Growth form: Foliose

Substrate: Hemlock, Lodgepole Pine, Ponderosa Pine, lignum

Site(s): South Fork Lost Horse Creek, Race Creek Trail, Vicinity of Fog Mountain Saddle, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23482, BRY C-26366 BRY C-26480, BRY C-28617, BRY C-29021

Evernia prunastri (L.) Ach.

Growth form: Fruticose

Substrate: *Thuja plicata*, Hemlock, *Amelanchier* sp., Douglas Fir, *Rhamnus purshiana*, *Alnus* sp.

Site(s): Race Creek Trail, vicinity of Fog Mountain Saddle, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead

Relative abundance: rare to locally common

Pollution sensitivity: sensitive to ozone; intermediately sensitive to sulfur dioxide (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26284, BRY C-26459, BRY C-26492, BRY C-26600, BRY C-28598, BRY C-28638, BRY C-28672, BRY C-28688, BRY C-28985

Hymenelia lacustris (With.) M. Choisy

Growth form: Crustose

Substrate: rocks submerged in creek

Site(s): vicinity of Fog Mountain Saddle, vicinity of White Cap Creek Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: This species is a new state record for Montana.

Deposition of specimens: BYU Herbarium: BRY C-26536, BRY C-29008

Hypogymnia austrodes (Nyl.) Räsänen

Growth form: Foliose

Substrate: Subalpine Fir, rock

Site(s): St. Mary's Peak, Carlton Ridge

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21871, BRY C-23406

Hypogymnia enteromorpha (Ach.) Nyl.

Growth form: Foliose

Substrate: Douglas Fir

Site(s): South Fork Lost Horse Creek, 8 km east of Bear Creek Pass, vicinity of White Cap Creek Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23483, BRY C-23515, BRY C-26507

Hypogymnia imshaugii Krog

Growth form: Foliose

Substrate: White Bark Pine, Subalpine Fir, lignum, River Hawthorn, Hemlock, Lodgepole Pine, Douglas Fir, Ponderosa Pine, Engelmann Spruce, *Thuja plicata*, *Alnus* sp.

Site(s): Nez Perce Pass, Carlton Lake, South Fork Lost Horse Creek, 8 km east of Bear Creek Pass, Race Creek Trail, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes

Relative abundance: common to abundant

Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)

Comments: None

Deposition of specimens: BYU Herbarium: BRY C-23335, BRY C-23407, BRY C-23408, BRY C-23490, BRY C-23491, BRY C-23492, BRY C-23493, BRY C-23494, BRY C-26281, BRY C-26289, BRY C-26414, BRY C-26419, BRY C-26425, BRY C-26441, BRY C-26450, BRY C-26464, BRY C-26479, BRY C-28587, BRY C-28657, BRY C-28663, BRY C-28680, BRY C-28978, BRY C-28999

Hypogymnia metaphysodes (Asah.) Rass.

Growth form: Foliose

Substrate: Hemlock, *Alnus* sp., *Thuja plicata*, Douglas Fir

Site(s): Race Creek Trail, Vicinity of Indian Hill, Below Indian Hill

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28588, BRY C-28594, BRY C-28645, BRY C-28658, BRY C-28682

Hypogymnia physodes (L.) Nyl.

Growth form: Foliose

Substrate: lignum, Subalpine Fir, Engelmann Spruce, *Alnus* sp., River Hawthorn, Douglas Fir, Hemlock, *Thuja plicata*, *Amelanchier* sp., Lodgepole Pine, Ponderosa Pine

Site(s): St. Mary's Peak, Mormon Ridge Trail, Carlton Ridge, South Fork Lost Horse Creek, 8 km east of Bear Creek Pass, Race Creek Trail, vicinity of Fog Mountain Saddle, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: rare to locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21855, BRY C-23409, BRY C-23410, BRY C-23495, BRY C-23496, BRY C-23497, BRY C-23498, BRY C-23499, BRY C-26276, BRY C-26338, BRY C-26343, BRY C-26454, BRY C-26475, BRY C-26506, BRY C-26522, BRY C-26624a, BRY C-28593, BRY C-28618, BRY C-28620, BRY C-28683, BRY C-28984, BRY C-29000

Hypogymnia tubulosa (Schraerer) Havaas

Growth form: Foliose

Substrate: Douglas Fir, Alnus sp., Thuja plicata

Site(s): 8 km east of Bear Creek Pass, South Fork Lost Horse Creek, Below Indian Hill, vicinity of Fish Hatchery, vicinity of Indian Hill

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23500, BRY C-23501, BRY C-26624b, BRY C-28681

Lecanora argentata (Ach.) Malme

Growth form: Crustose

Substrate: Subalpine Fir, Douglas Fir, Lodgepole Pine, Engelmann Spruce, White Bark Pine

Site(s): Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek, 8 km east of Bear Creek Pass, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, vicinity of Walton Lakes, along U.S.F.S. Road #468

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23336, BRY C-23411, BRY C-23502, BRY C-23503, BRY C-26386, BRY C-26397, BRY C-26416, BRY C-26420, BRY C-26426, BRY C-26442, BRY C-28659, BRY C-28677, BRY C-28977

Lecanora bicincta Ramond

Growth form: Crustose

Substrate: Rock

Site(s): St. Mary's Peak, Carlton ridge, South Fork Lost Horse Canyon

Relative abundance: Rare to locally common

Pollution sensitivity: Unknown

Comments: None

Deposition of specimens: BYU Herbarium: BRY C-21832, BRY C-23412, BRY C-23504

Lecanora cenisia Ach.

Growth form: Crustose

Substrate: rock

Site(s): St. Mary's Peak, Nez Perce Pass, vicinity of White Cap Creek Trail, along MaGruder Guard Station Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21837, BRY C-23337, BRY C-26291, BRY C-26356

Lecanora hageni (Ach.) Ach

Growth form: Crustose to obsolete
Substrate: detritus
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21879

Lecanora impudens Degel.

Growth form: Crustose
Substrate: Douglas Fir, lignum
Site(s): Nez Perce Pass, vicinity of Tenmile Creek, South Fork Lost Horse Creek
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23338, BRY C-23505, BRY C-23506, BRY C-23558

Lecanora mughicola Nyl.

Growth form: Crustose
Substrate: lignum
Site(s): Carlton Ridge, along U.S.F.S. Road #468
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: This taxon is a new species record for Montana
Deposition of specimens: BYU Herbarium: BRY C-23413, BRY C-26390

Lecanora muralis (Schreber) Rabenh.

Growth form: Crustose with effigurate margins
Substrate: rock
Site(s): Race Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28547

Lecanora polytropa (Hoffm.) Rabenh.

Growth form: Crustose to obsolete
Substrate: rock
Site(s): St. Mary's Peak, Carlton Ridge, vicinity of Fog Mountain Saddle
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21838, BRY C-23414, BRY C-29015

Lecanora pringlei (Tuck.) Lamb

Growth form: Crustose-subfruticose
Substrate: rock
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21830

Lecanora rupicola (L.) Zahlbr.

Growth form: Crustose
Substrate: rock
Site(s): along MaGruder Guard Station Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26357

Lecanora saligna (Schrader) Zahlbr.

Growth form: Crustose
Substrate: lignum
Site(s): Carlton Ridge, vicinity of Walton Lakes
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23415, BRY C-26492

Lecanora varia (Hoffm.) Ach.

Growth form: Crustose (often absent)
Substrate: lignum, Subalpine Fir
Site(s): vicinity of Walton Lakes
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26421, BRY C-26431

Lecidea atrobrunnea (Ramond *in* Lam. & DC.) Schaeerer

Growth form: Crustose
Substrate: rock
Site(s): St. Mary's Peak, Nez Perce Pass, Carlton Ridge, Bear Creek Pass, vicinity of Tenmile Creek, Race Creek Trail, vicinity of Fog Mountain Saddle, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes, along MaGruder Guard Station Trail, along U.S.F.S. Road #468
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: This species is one of the most common crustose, saxicolous lichens in western North America
Deposition of specimens: BYU Herbarium: BRY C-21840, BRY C-21841, BRY C-23339, BRY C-23416, BRY C-23488, BRY C-23507, BRY C-23559, BRY C-26320, BRY C-26360, BRY C-26539, BRY C-26548, BRY C-26582, BRY C-26590, BRY C-28542, BRY C-28995

Lecidea tessellata Flörke

Growth form: Crustose (absent)

Substrate: rock

Site(s): St. Mary's Peak, Nez Perce Pass, vicinity of Fog Mountain Saddle, along MaGruder Guard Station Trail, along U.S.F.S. Road #468

Relative abundance: common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21845, BRY C-23340, BRY C-26547, BRY C-26570, BRY C-28993

Lecidella euphorea (Flörke) Hertel

Growth form: Crustose

Substrate: lignum

Site(s): along U.S.F.S. Road #468

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26393

Lecidella stigmatica (Ach.) Hertel & Leuck.

Growth form: Crustose

Substrate: rock

Site(s): along MaGruder Guard Station Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26361

Lecidoma demissum (Rutstr.) G. Schneider & Hertel.

Growth form: Squamulose

Substrate: soil over rock, soil, humic soil

Site(s): Nez Perce Pass, Carlton Ridge, Bear Creek Pass, vicinity of Walton Lakes, along U.S.F.S. Road #468

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23341, BRY C-23417, BRY C-23489, BRY C-26374, BRY C-26567

Lepraria neglecta (Nyl.) Lettau

Growth form: Crustose-leprose

Substrate: soil over rock

Site(s): Bear Creek Pass

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23508

Leprocaulon subalbicans (Lamb) Lamb & Ward

Growth form: Sub-fruticose
Substrate: moss over rock
Site(s): Nez Perce Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23342

Leproloma membranaceum (Dickson) Vainio

Growth form: Crustose-Leprose
Substrate: moss over soil
Site(s): Carlton Ridge
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23418

Leptogium gelatinosum (With.) Laundon

Growth form: Foliose
Substrate: moss over rock
Site(s): Race Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28557

Leptogium lichenoides (L.) Zahlbr.

Growth form: Foliose
Substrate: moss over detritus, rock, moss over soil, moss over rock
Site(s): Nez Perce Pass, South Fork Lost Horse Creek, vicinity of Tenmile Creek,
Race Creek Trail, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle
Mountain Trailhead
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23343, BRY C-23509,
BRY C-23560, BRY C-26314, BRY C-26598, BRY C-26602b, BRY C-28564

Letharia columbiana (Nutt.) Thomson

Growth form: Fruticose
Substrate: lignum, White Bark Pine, Lodgepole Pine, Douglas Fir, Subalpine Fir
Site(s): St. Mary's Peak, Nez Perce Pass, Carlton Ridge, vicinity of Fog Mountain
Saddle, vicinity of Indian Hill, vicinity of Walton Lakes, along U.S.F.S. Road
#468
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21986, BRY C-22018,
BRY C-22275, BRY C-23344, BRY C-23419, BRY C-23420, BRY C-26385,
BRY C-26411, BRY C-26418, BRY C-26564, BRY C-28671, BRY C-28998

Letharia vulpina (L.) Hue

Growth form: Fruticose

Substrate: lignum, detritus, rock, River Hawthorn, Lodgepole Pine, Douglas Fir, Ponderosa Pine, Engelmann Spruce, White Bark Pine

Site(s): St. Mary's Peak, Nez Perce Pass, Carlton Ridge, Lost Horse Canyon, Mormon Ridge Trail, Carlton Lake, South Fork Lost Horse Creek, 8 km east of Bear Creek Pass, vicinity of Tenmile Creek, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes, along MaGruder Guard Station Trail, along U.S.F.S. Road #468

Relative abundance: locally abundant

Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)

Comments: This species has been collected for elemental analyses.

Deposition of specimens: BYU Herbarium: BRY C-21988, BRY C-21858,

BRY C-22057, BRY C-23345, BRY C-23421, BRY C-23422, BRY C-23423, BRY C-23424, BRY C-23425, BRY C-23484, BRY C-23485, BRY C-23486, BRY C-23487, BRY C-23510, BRY C-23511, BRY C-23512, BRY C-26333, BRY C-26337, BRY C-26345, BRY C-26381, BRY C-26384, BRY C-26391, BRY C-26412, BRY C-26446, BRY C-26477, BRY C-26563, BRY C-28670, BRY C-29007

Lobaria linita (Ach.) Rabenh.

Growth form: Foliose

Substrate: Thuja plicata, Douglas Fir

Site(s): Race Creek Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28560, BRY C-28567, BRY C-28611

Lobaria oregana (Tuck.) Müll

Growth form: Foliose

Substrate: moss over rock

Site(s): Race Creek Trail

Relative abundance: rare

Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28607

Lobaria pulmonaria (L.) Hoffm.

Growth form: Foliose

Substrate: moss over rock, Thuja plicata, Hemlock, Amelanchier sp., Douglas Fir, lignum

Site(s): Race Creek Trail, vicinity of Fog Mountain Saddle, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Fish Hatchery

Relative abundance: locally common to abundant

Pollution sensitivity: sensitive to sulfur dioxide

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26308, BRY C-26466, BRY C-26501, BRY C-26607, BRY C-26620, BRY C-28554, BRY C-28631, BRY C-28634, BRY C-28981

Megaspora verrucosa (Ach.) Hafellner & V.Wirth

Growth form: Crustose
Substrate: soil, detritus
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-22064

Melanelia exasperatula (Nyl.) Essl.

Growth form: Foliose
Substrate: Subalpine Fir
Site(s): vicinity of Fog Mountain Saddle
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28970

Melanelia olivaceoides (Krog) Essl.

Growth form: Foliose
Substrate: Douglas Fir
Site(s): Nez Perce Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: This taxon is a new species record for Montana.
Deposition of specimens: BYU Herbarium: BRY C-23346

Melanelia panniformis (Nyl.) Essl.

Growth form: Foliose
Substrate: rock
Site(s): vicinity of White Cap Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26312

Melanelia sorediata (Ach.) Goward & Ahti

Growth form: Foliose
Substrate: rock
Site(s): South Fork Lost Horse Creek, Race Creek Trail, vicinity of White Cap Creek Trail
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23513, BRY C-26292, BRY C-28571

Melanelia stygia (L.) Essl.

Growth form: Foliose

Substrate: rock

Site(s): St. Mary's Peak

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21821

Melanelia subaurifera (Nyl.) Essl.

Growth form: Foliose

Substrate: *Alnus* sp., *Rhamnus purshiana*

Site(s): Race Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead

Relative abundance: rare

Pollution sensitivity: sensitive to ozone; sensitive to NO_x/Pan (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26468, BRY C-28597

Melanelia subelegans (Essl.) Essl.

Growth form: Crustose

Substrate: Douglas Fir, lignum, Subalpine Fir,

Site(s): Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23347, BRY C-23426, BRY C-23427

Melanelia subolivacea (Nyl. in Hasse) Essl.

Growth form: Foliose

Substrate: Hemlock, Subalpine Fir

Site(s): Race Creek Trail, vicinity of Fog Mountain Saddle

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28581, BRY C-28971

Micarea assimilata (Nyl.) Coppins

Growth form: Crustose

Substrate: moss over detritus, soil, soil over rock, humic soil

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, Bear Creek Pass, along U.S.F.S. Road #468

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23348, BRY C-23516, BRY C-23517, BRY C-26373, BRY C-26377, BRY C-26401

Mycobilimbia berengeriana (Massal.) Hafellner & V. Wirth

Growth form: Crustose
Substrate: moss over rock
Site(s): Nez Perce Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23349

Neofuscelia brunella (Essl.) Essl.

Growth form: Foliose
Substrate: rock
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: This taxon is a new species record for Montana
Deposition of specimens: BYU Herbarium: BRY C-21816

Nephroma bellum (Sprengel) Tuck.

Growth form: Foliose
Substrate: rock
Site(s): along MaGruder Guard Station Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26521

Nephroma helveticum Ach.

Growth form: Foliose
Substrate: *Thuja plicata*, overgrowing *Lobaria pulmonaria*
Site(s): vicinity of Fish Hatchery
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26611, BRY C-26623

Nephroma parile (Ach.) Ach.

Growth form: Foliose
Substrate: moss over rock, rock, moss over wood, moss over soil, lignum, Douglas Fir
Site(s): South Fork Lost Horse Creek, Race Creek Trail, vicinity of White Cap Creek Trail, along MaGruder Guard Station Trail, along U.S.F.S. Road #468, vicinity of Fish Hatchery
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23561, BRY C-23562, BRY C-26302, BRY C-26306, BRY C-26307, BRY C-26355, BRY C-26369, BRY C-26514, BRY C-26545, BRY C-26711, BRY C-28550, BRY C-28625, BRY C-28633

Nephroma resupinatum (L.) Ach.

Growth form: Foliose

Substrate: *Alnus* sp., moss over rock, Douglas Fir, *Thuja plicata*, *Amelanchier* sp., *lingum*

Site(s): Race Creek Trail, vicinity of Fog Mountain Saddle, vicinity of White Cap Creek Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26309, BRY C-26502, BRY C-28605, BRY C-28607, BRY C-28608, BRY C-28650, BRY C-28980

Normandina pulchella (Borrer) Nyl.

Growth form: Crustose to obsolete

Substrate: moss over rock

Site(s): South Fork Lost Horse Creek

Relative abundance: rare

Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Wetmore 1987)

Comments: This taxon is a new species record for Montana

Deposition of specimens: BYU Herbarium: BRY C-23518

Ochrolechia androgyna (Hoffm.) Arnold

Growth form: Crustose

Substrate: lignum

Site(s): 8 km east of Bear Creek Pass

Relative abundance: rare

Pollution sensitivity: sensitive to sulfur dioxide (Wetmore 1987)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23563

Ochrolechia upsaliensis (L.) Massal.

Growth form: Crustose

Substrate: detritus

Site(s): St. Mary's Peak

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-22058

Pannaria conoplea (Ach.) Bory

Growth form: Squamulose

Substrate: soil over rock, moss over rock

Site(s): Nez Perce Pass, Bear Creek Pass at head of Lost Horse Canyon

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23350, BRY C-23519

Pannaria pezizoides (Weber) Trevisan

Growth form: Squamulose

Substrate: soil, moss over soil

Site(s): Nez Perce Pass, along U.S.F.S. Road #468, vicinity of Fish Hatchery

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23351, BRY C-26410,
BRY C-26719, BRY C-26721

Parmelia hygrophila Goward & Ahti

Growth form: Foliose

Substrate: Douglas Fir, rock

Site(s): vicinity of White Cap Creek Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26323, BRY C-26508,
BRY C-26512

Parmelia saxatilis (L.) Ach.

Growth form: Foliose

Substrate: rock, moss over rock, *Thuja plicata*, moss

Site(s): Nez Perce Pass, Carlton Ridge, 8 km east of Bear Creek Pass, Race Creek
Trail, vicinity of Indian Hill, vicinity of White Cap Creek Trail

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987);
sensitive to fluoride (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23352, BRY C-23428,
BRY C-23520, BRY C-26316, BRY C-28570, BRY C-28627, BRY C-28632,
BRY C-28661

Parmelia sulcata Taylor

Growth form: Foliose

Substrate: detritus, rock, *Alnus* sp., River Hawthorn, Douglas Fir, Hemlock, River
Birch, *Thuja plicata*, *Rhamnus purshiana*, *Amelanchier* sp.

Site(s): St. Mary's Peak, Nez Perce Pass, Bear Creek Pass at head of Lost Horse
Canyon, South Fork Lost Horse Creek, Race Creek Trail, vicinity of Fog Mountain
Saddle, Wilderness Gateway-Eagle Mountain Trailhead

Relative abundance: locally common

Pollution sensitivity: sensitive to intermediately sensitive to ozone; intermediately
sensitive to sulfur dioxide; sensitive to fluoride (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21877, BRY C-23353,
BRY C-23521, BRY C-23522, BRY C-23523, BRY C-23524, BRY C-23564,
BRY C-26465, BRY C-28584, BRY C-28592, BRY C-28595, BRY C-28619,
BRY C-28989

Parmeliopsis ambigua (Wulfen in Jacq.) Nyl.

Growth form: Foliose

Substrate: moss over soil, lignum, Douglas Fir, Subalpine Fir, Ponderosa Pine, decomposing wood, *Thuja plicata*

Site(s): Nez Perce Pass, 8 km east of Bear Creek Pass, South Fork Lost Horse Creek, vicinity of Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes, along MaGruder Guard Station Trail, along U.S.F.S. Road #468, vicinity of Fish Hatchery

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23354, BRY C-23355, BRY C-23356, BRY C-23525, BRY C-23526, BRY C-26299, BRY C-26328, BRY C-26389, BRY C-26444, BRY C-26497, BRY C-26627, BRY C-28668

Parmeliopsis hyperopta (Ach.) Arnold

Growth form: Foliose

Substrate: lignum, Subalpine Fir

Site(s): Nez Perce Pass, Bear Creek Pass at head of Lost Horse Canyon, South Fork Lost Horse Creek, vicinity of Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23357, BRY C-23527, BRY C-23528, BRY C-26305, BRY C-26445, BRY C-26499, BRY C-28669

Peltigera aphthosa (L.) Willd.

Growth form: Foliose

Substrate: moss over soil, detritus, moss over rock, moss over wood, humic soil

Site(s): Nez Perce Pass, Carlton Ridge, Race Creek Trail, vicinity of White Cap Creek Trail, along MaGruder Guard Station Trail, along U.S.F.S. Road #468, vicinity of Fish Hatchery

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23358, BRY C-23429, BRY C-26301, BRY C-26303b, BRY C-26346, BRY C-26407, BRY C-26702, BRY C-28602, BRY C-28632

Peltigera canina (L.) Willd.

Growth form: Foliose

Substrate: moss over soil, detritus, Hemlock, moss over rock, moss over wood, humic soil

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, 12 km east of Bear Creek Pass, Race Creek Trail, vicinity of White Cap Creek Trail, along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: locally common

Pollution sensitivity: sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23359, BRY C-26300, BRY C-26303a, BRY C-26350, BRY C-26706, BRY C-28589, BRY C-28603

Peltigera collina (Ach.) Schrader

Growth form: Foliose

Substrate: moss over soil, moss over wood, Douglas Fir, moss over rock

Site(s): Nez Perce Pass, Race Creek Trail, vicinity of White Cap Creek Trail

Relative abundance: rare

Pollution sensitivity: sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23360, BRY C-28558,
BRY C-28626

Peltigera didactyla (With.) Laundon

Growth form: Foliose

Substrate: moss over soil

Site(s): vicinity of Walton Lakes

Relative abundance: rare

Pollution sensitivity: sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26579

Peltigera lepidophora (Nyl. ex Vainio) Bitter

Growth form: Foliose

Substrate: soil

Site(s): St. Mary's Peak

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21989

Peltigera malacea (Ach.) Funck

Growth form: Foliose

Substrate: moss over soil, detritus, rock

Site(s): Nez Perce Pass, 12 km east of Bear Creek Pass, South Fork Lost Horse Creek

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23361, BRY C-23567,
BRY C-23568

Peltigera membranacea (Ach.) Nyl.

Growth form: Foliose

Substrate: humic soil, moss over soil

Site(s): along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26329, BRY C-26612

Peltigera neckeri Hepp

Growth form: Foliose
Substrate: moss over rock
Site(s): Race Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28604

Peltigera pacifica Vitik.

Growth form: Foliose
Substrate: moss at base of conifer
Site(s): vicinity of Fish Hatchery
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26703

Peltigera polydactyla (Necker) Hoffm.

Growth form: Foliose
Substrate: soil
Site(s): South Fork Lost Horse Creek
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23569

Peltigera praetextata (Flörke ex Sommerf.) Zopf

Growth form: Foliose
Substrate: moss over rock, soil
Site(s): Race Creek Trail, vicinity of White Cap Creek Trail, vicinity of Walton Lakes
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26286, BRY C-26433,
BRY C-28565

Peltigera rufescens (Weis) Humb.

Growth form: Foliose
Substrate: humic soil
Site(s): along MaGruder Guard Station Trail
Relative abundance: locally common
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26347

Peltigera venosa (L.) Hoffm.

Growth form: Foliose

Substrate: soil, soil over rock, moss over soil

Site(s): Nez Perce Pass, vicinity of Fog Mountain Saddle, vicinity of Walton Lakes, along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23362, BRY C-26363, BRY C-26435, BRY C-26615, BRY C-26704, BRY C-29026

Pertusaria amara (Ach.) Nyl.

Growth form: Crustose

Substrate: Douglas Fir, *Thuja plicata*

Site(s): vicinity of White Cap Creek Trail, vicinity of Fish Hatchery

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26285, BRY C-26618

Pertusaria subambigens Dibben

Growth form: Crustose

Substrate: Hemlock, River Birch

Site(s): Race Creek Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28578, BRY C-28591, BRY C-28612

Phaeophyscia constipata (Norrlin & Nyl.) Moberg

Growth form: Foliose

Substrate: soil over rock

Site(s): Nez Perce Pass

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23363

Phaeophyscia endococcina (Körber) Moberg.

Growth form: Foliose

Substrate: rock

Site(s): South Fork Lost Horse Canyon

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23570

Phaeorrhiza nimbosa (Fr.) Mayrh. & Poelt

Growth form: Squamulose
Substrate: soil, detritus
Site(s): St. Mary's Peak
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21875

Physcia biziana (Massal.) Zahlbr.

Growth form: Foliose
Substrate: rock, Douglas Fir
Site(s): Nez Perce Pass, South Fork Lost Horse Creek
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23364, BRY C-23365, BRY C-23529, BRY C-23571

Physcia caesia (Hoffm.) Fürnr.

Growth form: Foliose
Substrate: rock
Site(s): Nez Perce Pass, along U.S.F.S. Road #468
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23366, BRY C-26546

Physcia phaea (Tuck.) Thomson

Growth form: Foliose
Substrate: rock, moss over rock
Site(s): South Fork Lost Horse Creek, Race Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23572, BRY C-28566

Physcia stellaris (L.) Nyl.

Growth form: Foliose
Substrate: Hemlock
Site(s): Race Creek Trail
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-28580

Physconia detera (Nyl.) Poelt

Growth form: Foliose
Substrate: moss over rock
Site(s): Nez Perce Pass, South Fork Lost Horse Creek
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23367, BRY C-23573

Physconia muscigena (Ach.) Poelt

Growth form: Foliose

Substrate: moss, detritus

Site(s): Nez Perce Pass, vicinity of Tenmile Creek

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23368, BRY C-23574

Physconia perisidiosa (Erichsen) Moberg

Growth form: Foliose

Substrate: moss, detritus, moss over rock

Site(s): Nez Perce Pass, South Fork Lost Horse Creek

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23369, BRY C-23575

Platismatia glauca (L.) Culb. & C. Culb.

Growth form: Foliose

Substrate: lignum, Douglas Fir, Hemlock, *Thuja plicata*, Ponderosa Pine, Amelanchier sp., Lodgepole Pine, *Alnus* sp., moss over rock

Site(s): Carlton Ridge, 8 km east of Bear Creek Pass, vicinity of Tenmile Creek, South Fork Lost Horse Creek, Race Creek Trail, vicinity of Fog Mountain Saddle, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: rare to locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987); sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23430, BRY C-23576, BRY C-23577, BRY C-23578, BRY C-26280, BRY C-26340, BRY C-26463, BRY C-26486, BRY C-26493, BRY C-26505, BRY C-26509, BRY C-26511, BRY C-26516, BRY C-26608, BRY C-26621, BRY C-28585, BRY C-28623, BRY C-28653, BRY C-28689, BRY C-28988, BRY C-28996

Platismatia herrei (Imsh.) Culb. & C. Culb.

Growth form: Foliose

Substrate: Douglas Fir, Hemlock

Site(s): South Fork Lost Horse Creek, vicinity of Tenmile Creek, Race Creek Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: This taxon is a new species record for Montana

Deposition of specimens: BYU Herbarium: BRY C-23579, BRY C-23580, BRY C-28635

Polychidium muscicola (Swartz) Gray

Growth form: Minutely fruticose

Substrate: moss over rock

Site(s): vicinity of Tenmile Creek, Wilderness Gateway-Eagle Mountain Trailhead

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23581, BRY C-26599

Protoparmelia badia (Hoffm.) Hafellner

Growth form: Crustose

Substrate: rock

Site(s): St. Mary's Peak, Carlton Ridge

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21872, BRY C-23431

Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw.

Growth form: Fruticose

Substrate: rock

Site(s): St. Mary's Peak, Carlton Ridge

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21846, BRY C-23432

Pseudephebe pubescens (L.) M. Choisy

Growth form: Fruticose

Substrate: rock

Site(s): St. Mary's Peak, 8 km east of Bear Creek Pass, vicinity of Walton Lakes

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21822, BRY C-23530,

BRY C-26551

Psora nipponica (Zahlbr.) G. Schneider

Growth form: Squamulose

Substrate: soil over rock

Site(s): Nez Perce Pass, Carlton Ridge, vicinity of White Cap Creek Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23370, BRY C-23433,

BRY C-26315

Psoroma hypnorum (Vahl) Gray

Growth form: Squamulose

Substrate: moss over rock, soil, Douglas Fir, moss over soil

Site(s): Nez Perce Pass, Carlton Lake, vicinity of Tenmile Creek, vicinity of Walton Lakes, along MaGruder Guard Station Trail, along U.S.F.S. Road #468, vicinity of Fish Hatchery

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23371, BRY C-23372,

BRY C-23434, BRY C-23582, BRY C-26368, BRY C-26409, BRY C-26528,

BRY C-26556, BRY C-26616

Ramalina dilacerata (Hoffm.) Hoffm.

Growth form: Fruticose
Substrate: Rhamnus purshiana
Site(s): Wilderness Gateway-Eagle Mountain Trailhead
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26467

Rhizocarpon disporum (Naeg. ex Hepp) Müll. Arg.

Growth form: Crustose
Substrate: rock
Site(s): Nez Perce Pass, vicinity of Tenmile Creek, Race Creek Trail, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23373, BRY C-23583, BRY C-26294, BRY C-26331, BRY C-26527, BRY C-26592, BRY C-28544

Rhizocarpon geographicum (L.) DC.

Growth form: Crustose
Substrate: rock
Site(s): St. Mary's Peak, Nez Perce Pass, Carlton Ridge, Bear Creek Pass, vicinity of Tenmile Creek, vicinity of Fog Mountain Saddle, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail, along U.S.F.S. Road #468
Relative abundance: common to abundant
Pollution sensitivity: sensitive to fluoride (Ryan 1990)
Comments: This is one of the more common, high elevation saxicolous lichen species in the world.
Deposition of specimens: BYU Herbarium: BRY C-23374, BRY C-23435, BRY C-23531, BRY C-23586, BRY C-26370, BRY C-26518, BRY C-26588, BRY C-26589, BRY C-28991

Rhizocarpon grande (Flörke ex Flotow) Arnold

Growth form: Crustose
Substrate: rock
Site(s): South Fork Lost Horse Creek
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23532

Rhizocarpon hochstetteri (Körber) Vainio

Growth form: Crustose
Substrate: rock
Site(s): Lost Horse Creek
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23584

Rhizocarpon riparium Räsänen

Growth form: Crustose

Substrate: rock

Site(s): Nez Perce Pass, Carlton Ridge, Bear Creek Pass, South Fork Lost Horse Creek, vicinity of Tenmile Creek

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23375, BRY C-23436, BRY C-23533, BRY C-23534, BRY C-23585

Rhizocarpon sphaerosporum Räsänen

Growth form: Crustose

Substrate: rock

Site(s): vicinity of Fog Mountain Saddle, along U.S.F.S. Road #468

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26538, BRY C-28990

Rhizoplaca chrysoleuca (Sm.) Zopf.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Carlton Ridge, vicinity of Fog Mountain Saddle

Relative abundance: rare to locally common

Pollution sensitivity: sensitive to sulfur dioxide; sensitive to nitrous oxides and PAN (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23437, BRY C-29018

Rhizoplaca melanophthalma (DC. in Lam. & DC.) Leuck & Poelt

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): St. Mary's Peak, Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek, vicinity of Fog Mountain Saddle, vicinity of Indian Hill

Relative abundance: locally common

Pollution sensitivity: sensitive to sulfur dioxide (Hale 1982)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21823, BRY C-23376, BRY C-23438, BRY C-23535, BRY C-28678, BRY C-29019

Rhizoplaca peltata (Ramond) Leuck. & Poelt

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): South Fork Lost Horse Creek

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23536

Rinodina turfacea (Wahlenb.) Körber

Growth form: Crustose
Substrate: detritus
Site(s): St. Mary's Peak
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21876

Sarcogyne regularis Körber

Growth form: Crustose
Substrate: rock
Site(s): Bear Creek Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23537

Solorina crocea (L.) Ach.

Growth form: Foliose
Substrate: soil over rock, soil, humic soil
Site(s): Nez Perce Pass, Carlton Ridge, vicinity of Walton Lakes, along U.S.F.S.
Road #468
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23377, BRY C-23439,
BRY C-26554

Sporastatia polyspora (Nyl.) Grumm.

Growth form: Crustose
Substrate: rock
Site(s): Carlton Ridge
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23440

Sporastatia testudinea (Ach.) Massal.

Growth form: Crustose
Substrate: rock
Site(s): St. Mary's Peak
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-21850

Stereocaulon alpinum Laurer ex Funck

Growth form: Squamulose (with podetia)

Substrate: soil

Site(s): Carlton Ridge

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23441

Stereocaulon tomentosum Fr.

Growth form: Squamulose (with podetia)

Substrate: soil over rock, humic soil

Site(s): along MaGruder Guard Station Trail, along U.S.F.S. Road #468

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26408, BRY C-26520

Tephromela armeniaca (DC.) Hertel & Rambold

Growth form: Crustose

Substrate: rock

Site(s): St. Mary's Peak

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21851

Thamnolia subuliformis (Ehrh.) Culb.

Growth form: Fruticose

Substrate: soil, detritus

Site(s): St. Mary's Peak

Relative abundance: locally common to abundant

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21856

Trapeliopsis granulosa (Hoffm.) Lumbsch.

Growth form: Crustose

Substrate: detritus, lignum, humic soil, soil over rock, burned lignum, decomposing wood, soil

Site(s): Nez Perce Pass, Carlton Ridge, Bear Creek Pass, 8 km east of Bear Creek Pass, South Fork Lost Horse Creek, vicinity of Walton Lakes, along MaGruder Guard Station Trail, along U.S.F.S. Road #468

Relative abundance: locally abundant

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23378, BRY C-23442,

BRY C-23538, BRY C-23539, BRY C-23540, BRY C-23541, BRY C-23542,

BRY C-26327, BRY C-26375, BRY C-26402, BRY C-26440

Tremolecia atrata (Ach.) Hertel

Growth form: Crustose
Substrate: rock
Site(s): Carlton Ridge
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23443

Tuckermannopsis canadensis (Räsänen) Hale

Growth form: Foliose
Substrate: Douglas Fir, Ponderosa Pine
Site(s): vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead
Relative abundance: rare
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26279, BRY C-26288, BRY C-26473

Tuckermannopsis chlorophylla (Willd. in Humb.) Hale

Growth form: Foliose
Substrate: *Alnus* sp., *lignum*, Hemlock, *Thuja plicata*, Ponderosa Pine, Subalpine Fir, Douglas Fir
Site(s): Nez Perce Pass, South Fork Lost Horse Creek, Race Creek Trail, vicinity of Fog Mountain Saddle, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23380, BRY C-23587, BRY C-23588, BRY C-23589, BRY C-26278, BRY C-26339, BRY C-26344, BRY C-26352, BRY C-26461, BRY C-26481b, BRY C-26494, BRY C-26510, BRY C-28583, BRY C-28596, BRY C-28624, BRY C-28652, BRY C-28690, BRY C-28968

Tuckermannopsis merrillii (Du Rietz) Hale

Growth form: Foliose
Substrate: White Bark Pine, Douglas Fir, Lodgepole Pine, Ponderosa Pine
Site(s): Carlton Ridge, 8 km east of Bear Creek Pass, vicinity of Fog Mountain Saddle, Wilderness Gateway-Eagle Mountain Trailhead
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23444, BRY C-23543, BRY C-26482, BRY C-29005

Tuckermannopsis orbata (Nyl.) Lai

Growth form: Foliose

Substrate: Hemlock, Subalpine Fir

Site(s): Race Creek Trail, vicinity of Fog Mountain Saddle

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28636, BRY C-28969

Tuckermannopsis platyphylla (Tuck.) Hale

Growth form: Foliose

Substrate: River Hawthorn, Lodgepole Pine, Douglas Fir, Subalpine Fir, Ponderosa Pine, Engelmann Spruce, *Alnus* sp.

Site(s): Nez Perce Pass, 8 km east of Bear Creek Pass, South Fork Lost Horse Creek, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23381, BRY C-23544, BRY C-23590, BRY C-23591, BRY C-23592, BRY C-26283, BRY C-26415, BRY C-26438, BRY C-26449, BRY C-26462, BRY C-26481a, BRY C-28675, BRY C-28676, BRY C-28691, BRY C-29006

Umbilicaria americana (L.) Poelt & Nash

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): vicinity of White Cap Creek Trail, along U.S.F.S. Road #468

Relative abundance: locally common to abundant

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26313, BRY C-26542

Umbilicaria decussata (Vill.) Zahlbr.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): St. Mary's Peak, vicinity of Walton Lakes

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21825, BRY C-26565

Umbilicaria deusta (L.) Baumg.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Carlton Ridge, Bear Creek Pass, along MaGruder Guard Station Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23445, BRY C-23545, BRY C-26524

Umbilicaria hyperborea (Ach.) Hoffm.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): St. Mary's Peak, Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek, vicinity of Tenmile Creek, vicinity of Fog Mountain Saddle, vicinity of Walton Lakes, along U.S.F.S. Road #468

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21824a, BRY C-21824, BRY C-23382, BRY C-23446, BRY C-23546, BRY C-23593, BRY C-26436, BRY C-26437, BRY C-26541, BRY C-26553, BRY C-26566, BRY C-28966

Umbilicaria krascheninnikovii (Savicz) Zahlbr.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Carlton Ridge

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23447

Umbilicaria phaea Tuck.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): South Fork Lost Horse Creek, vicinity of Tenmile Creek

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23547, BRY C-23594

Umbilicaria polyphylla (L.) Baumg.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Carlton Ridge, 8 km east of Bear Creek Pass, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, Wilderness Gateway-Eagle Mountain Trailhead

Relative abundance: rare

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23448, BRY C-23548, BRY C-26594, BRY C-28660, BRY C-29020

Umbilicaria torrefacta (Lightf.) Schrader

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek, Bear Creek Pass, vicinity of Tenmile Creek, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23383, BRY C-23441, BRY C-23549, BRY C-23550, BRY C-23595, BRY C-26310, BRY C-26595, BRY C-26601

Umbilicaria vellea (L.) Ach.

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): Bear Creek Pass, Nez Perce Pass, South Fork Lost Horse Creek, vicinity of Indian Hill, Wilderness Gateway-Eagle Mountain Trailhead, St. Mary's Peak

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-211826, BRY C-23384, BRY C-23551, BRY C-23552, BRY C-26593, BRY C-28662, BRY C35000

Umbilicaria virginis Schaeer

Growth form: Foliose (umbilicate)

Substrate: rock

Site(s): St. Mary's Peak, Carlton Ridge

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21827, BRY C-23450

Usnea alpina Mot.

Growth form: Fruticose

Substrate: Hemlock

Site(s): Race Creek Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28575

Usnea hirta (L.) Weber ex Wigg.

Growth form: Fruticose

Substrate: *Alnus* sp.

Site(s): vicinity of Indian Hill

Relative abundance: rare

Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Wetmore 1987)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-28687

Usnea lapponica Vainio

Growth form: Fruticose

Substrate: Engelmann Spruce, Doug Fir, River Hawthorn, Hemlock, *Thuja plicata*, *Amelanchier* sp.

Site(s): South Fork Lost Horse Creek, Race Creek Trail, vicinity of Fog Mountain Saddle

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23553, BRY C-23554, BRY C-23555, BRY C-28576, BRY C-28621, BRY C-28987

Usnea longissima Ach.

Growth form: Fruticose
Substrate: Douglas Fir
Site(s): Wilderness Gateway-Eagle Mountain Trailhead
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26491

Usnea subfloridana Stirton

Growth form: Fruticose
Substrate: *Alnus* sp., Subalpine Fir, Douglas Fir, Ponderosa Pine, *Rhamnus prushiana*
Site(s): South Fork Lost Horse Canyon, vicinity of Fog Mountain Saddle, Wilderness Gateway-Eagle Mountain Trailhead
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23556, BRY C-26457, BRY C-26476, BRY C-26483, BRY C-26484, BRY C-26485, BRY C-28972

Xanthoparmelia coloradoensis (Gyelnik) Hale

Growth form: Foliose
Substrate: rock
Site(s): vicinity of White Cap Creek Trail
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26321

Xanthoparmelia cumberlandia (Gyelnik) Hale

Growth form: Foliose
Substrate: rock
Site(s): Race Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-26452, BRY C-28549

Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale

Growth form: Foliose
Substrate: rock
Site(s): South Fork Lost Horse Creek
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23557

Xanthoria candelaria (L.) Th. Fr.

Growth form: Foliose

Substrate: Douglas Fir, lignum, *Thuja plicata*

Site(s): South Fork Lost Horse Creek, Race Creek Trail, along MaGruder Guard Station Trail

Relative abundance: rare

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987); sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23596, BRY C-26335, BRY C-26336, BRY C-28646, BRY C-28647

Xanthoria elegans (Link) Th. Fr.

Growth form: Minutely fruticose

Substrate: rock

Site(s): South Fork Lost Horse Creek

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23597

Xanthoria fallax (Hepp in Arnold) Arnold

Growth form: Foliose

Substrate: Douglas Fir, lignum, rock

Site(s): Carlton Ridge, South Fork Lost Horse Creek

Relative abundance: rare

Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Wetmore 1987); sensitive to nitrous oxides and PAN (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23451, BRY C-23598, BRY C-23599

Xanthoria polycarpa (Hoffm.) Rieber

Growth form: Fruticose

Substrate: *Ribes* sp.

Site(s): vicinity of White Cap Creek Trail

Relative abundance: rare to locally common

Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26518

Xylographa abietina (Pers.) Zahlbr.

Growth form: Crustose

Substrate: lignum

Site(s): Nez Perce Pass, vicinity of Walton Lakes

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23385, BRY C-26430

Xylographa vitiliga (Ach.) Laundon
Growth form: Obsolete, endoxylic
Substrate: lignum
Site(s): Nez Perce Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-23386

OBSERVATIONS AND CONCLUSIONS:

1. The lichen flora of the Selway-Bitterroot Wilderness Area is diverse and well developed. From our collections at the 15 reference sites we have identified a total of 210 species in 82 genera including a total of seven new species records for Montana and Idaho. All growth forms are well represented; however the flora is dominated by foliose species (41.4%, 87 species), followed by crustose species (32.4%, 68 species). Squamulose lichens makes up 14.3% of the flora (30 species); while fruticose species comprise 11.9% of the flora with 25 species. Generally, this growth form pattern seems to be typical of the lichen floras of the Pacific Northwest. In contrast, other Rocky Mountain lichen floras are dominated by crustose species (e.g. 48% in the Bridger Wilderness Area, and 50% in the High Uintas Wilderness Area; with foliose species representing only 28% and 29% of the lichen floras of these wilderness areas).
2. During this study lichens were collected from 5 basic substrates: rocks, lignum/bark, moss/detritus, soil and the thalli of other lichen species. A total of 65 species (31% of the flora) were collected from various rock substrates. Bark and lignum species came in a close second, totaling 63 species (30% of the flora). Forty-four species (21% of the flora) were collected from moss/detritus substrates with 37 species (17% of the flora) collected from the soil. Finally, 1 species (<1% of the flora) occurred as an epiphyte on other lichen species. Most Intermountain Area lichen floras are dominated by saxicolous (rock) species. For example, 37% (67 species) of the lichen flora from the High Uintas Wilderness Area (northeastern Utah) are from saxicolous substrates with only 23% (41 species) from corticolous (bark and lignum) substrates. The Bridger Wilderness Area, in western Wyoming, shows a similar pattern with 51% (76 species) reported from rock substrates and only 23% (35 species) from bark and lignum. The relatively even distribution pattern between rock and bark/lignum substrates in the Selway Bitterroot Wilderness Area suggests an increasing Pacific-Northwest influence, especially in the western portion of the wilderness area. This interpretation becomes even clearer when the substrate distribution patterns for only those sites in the Idaho panhandle are considered. For example, the pattern for the three reference sites at the western boundary of the wilderness area (Fog Mountain Saddle, Race Creek Trail and Indian Hill) is clearly dominated by corticolous species (52%, 41 species); with only 24% (19 species) of the flora coming from rock substrates. The influence of regional weather patterns, along with the occurrence of well-developed, appropriate microhabitats and the dispersal of asexual/sexual propagules by prevailing winds has effectively accommodated the movement of Pacific Northwest lichens into the Idaho panhandle and adjacent areas of western Montana.
3. High species diversity as well as an abundance of all basic growth forms indicates that the lichen communities in the Selway-Bitterroot Wilderness Area are healthy and generally not impacted by air pollutants.

4. The abundance of sensitive indicator species at all reference sites (see Appendix A) further documents that the lichen flora in the wilderness area is diverse and healthy.
5. The general absence of necrotic and/or bleached thalli also suggests that the lichen flora is unimpacted.
6. Baseline concentrations of potential pollutant elements were determined by analyzing the tissues of at least one sensitive indicator species from each reference site (table 1). Thallus concentrations of most potential pollutant elements are well within background levels (figure 2). The only samples with somewhat elevated elemental concentrations were *Umbilicaria vellea* from St. Mary's Peak (sulfur = .23%), *Umbilicaria vellea* from Bear Creek Pass (nickel = 12 ppm and copper = 220 ppm) and *Letharia vulpina* from Carlton Lakes (nickel = 8 ppm and copper = 260 ppm). The high sulfur value for *Umbilicaria vellea* from St. Mary's Peak is somewhat of an enigma; especially since all of the other samples recorded low values for this element. Occasionally, some saxicolous lichens (i.e. *Dermatocarpon* spp.) selectively occupy sulfur enriched substrates. I suspect that this may be the case with the *Umbilicaria vellea* sample from St. Mary's Peak. Therefore, I am confident that the high sulfur levels from this sample do not necessarily indicate air pollution impact. This is further verified by the consistently low sulfur values reported for all the other sensitive indicator species from the Selway-Bitterroot Wilderness Area as well as the Anaconda-Pintler and the Cabinet Mountains wilderness areas. The slightly elevated levels of nickel and copper in the other two species is also somewhat difficult to explain. In neither case do the concentrations approach elevated levels typical of samples collected at significantly polluted sites. However, compared to samples from the other reference sites in the wilderness they are substantially higher. In the case of the *Umbilicaria vellea* from Bear Creek Pass I am inclined again to think that we may be seeing some substrate enrichment; however, that would not be true of the lignicolous *Letharia vulpina* from Carlton Lakes. The source of the elevated concentrations of nickel in the Carlton Lake sample may in some measure be related to the high nickel levels observed in samples of the same species from the Anaconda-Pintler Wilderness Area. Finally, some of the samples show moderately high levels of titanium (305-1100 ppm) and zinc (113-420 ppm); however, since both of these elements are common components of many soils and rock substrates these values probably represent normal local background concentrations. Finally, sample #33-281 (*Alectoria sarmentosa*) collected near the fish hatchery along U.S. Forest Service Road #362 showed elevated levels of Nickel, copper and zinc (Ni = 29.1 ppm, Cu = 306 ppm and Zn = 166 ppm). Careful examination of the three replicate samples showed that two of the replicates were consistently high for those three elements, while values from the third replicate sample were well within background levels. I suspect that the elevated nickel, copper and zinc values in sample #33-281 is an aberrant event likely due to a wind blown particle unusually rich in those elements. Pollutant concentrations for all other samples collected during the 1993 and 1994 field seasons are well within background levels.

RECOMMENDATIONS:

1. Eventually, 2-3 additional reference sites should be established along the northern boundary of the wilderness area (possibly, near Mocus Point, Hoodoo Mountain and Spruce Creek Lakes). Two additional sites should also be established along the southwestern boundary of the wilderness (possibly, along Running Creek and near Elk Mountain or Running Lake). These additional sites will provide further

TABLE #1: Mean concentrations of potential pollutant elements in sensitive indicator species from air quality biomonitoring reference sites in and near the Selway Bitterroot Wilderness Area.

Species and Collection Site	Elements (ppm except where indicated)									
	S%	Cl	K%	Ca%	Ti	V	Cr	Ni	Cu	Zn
<i>Umbilicaria vellea</i> , Bear Creek Pass, Sample #152	0.11	250	0.56	0.12	330	n.d.	n.d.	12	220	420
<i>Letharia vulpina</i> , Carlton Lakes, Sample #156	0.08	n.d.	0.25	0.22	92	n.d.	n.d.	8	260	170
<i>Parmelia saxatilis</i> , Nez Perce Pass, Sample #157	0.14	1000	1.02	1.02	1100	n.d.	n.d.	n.d.	49	202
<i>Umbilicaria vellea</i> , St. Mary's Peak, Sample #160	0.23	46	0.48	0.053	305	n.d.	n.d.	n.d.	44	113
<i>Alectoria sarmentosa</i> , Race Creek Trail, Sample #199	0.017	56	0.17	0.28	22	n.d.	n.d.	6.8	0.5	11
<i>Lobaria pulmonaria</i> , Race Creek Trail, Sample #200	0.046	220	0.4	0.056	76	3.7	0.95	0.5	4.2	18
<i>Lobaria pulmonaria</i> , Race Creek Trail, Sample #201	0.058	240	0.48	0.255	200	8.5	2.8	2.9	5.4	19
<i>Letharia vulpina</i> , Fog Mountain Saddle, Sample #202	0.05	170	0.29	0.32	49	n.d.	n.d.	0.75	1.8	20
<i>Umbilicaria hyperborea</i> , Fog Mountain Saddle, Sample #203	0.11	130	0.29	0.125	325	15	3.4	2.4	5.1	47.3
<i>Letharia vulpina</i> , USFS Road #290, Sample #204	0.064	190	0.36	0.41	120	n.d.	n.d.	0.96	2.8	28
<i>Alectoria sarmentosa</i> , Indian Hill, Sample #205	0.014	72	0.1	0.073	20	n.d.	n.d.	0.1	2.1	7
<i>Umbilicaria vellea</i> , Indian Hill, Sample #206	0.074	186	0.33	0.08	440	19	4.1	1.9	7	130

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)									
	S%	Cl	K%	Ca%	Ti	V	Cr	Ni	Cu	Zn
<i>Bryoria fremontii</i> , Walton Lakes, Sample #268	0.092	569	0.503	0.139	36.2	n.d.	n.d.	1.37	3.4	30.1
<i>Letharia vulpina</i> , Walton Lakes, Sample #269	0.06	389	0.214	0.115	67.9	n.d.	n.d.	1.1	1.73	20.9
<i>Umbilicaria hyperborea</i> , Walton Lakes, Sample #271	0.129	338	0.358	0.138	426	125	3.88	3.07	8.16	56.8
<i>Lobaria pulmonaria</i> , Eagle Mt. Trailhead, Sample #273	0.094	454	0.489	0.15	72.9	n.d.	3.23	0.687	1.69	17.6
<i>Lobaria pulmonaria</i> , Wilderness Gateway, Sample #274	0.06	440	0.557	0.233	195	7.01	2.52	0.673	3.69	7.84
<i>Umbilicaria polyphylla</i> , Wild. Gateway, Sample #275	0.05	306	0.235	0.114	426	13.5	5.68	2.94	4.61	17.1
<i>Usnea subfloridana</i> , Wilderness Gateway, Sample #279	0.051	408	0.456	0.389	67.6	n.d.	n.d.	0.564	3.11	33.7
<i>Xanthoparmelia cumberlandia</i> , Gateway, Sample #280	0.064	330	0.501	0.316	859	16	6.95	3.64	9.31	49.1
<i>Bryoria sarmentosa</i> , Fish Hatchery, Sample #281	0.034	344	0.129	0.495	15	n.d.	1.16	29.1	306	166
<i>Lobaria pulmonaria</i> , Fish Hatchery, Sample #283	0.063	279	0.579	0.137	111	n.d.	1.28	0.49	2.41	13.6
<i>Bryoria fremontii</i> , Mac Gruder G.S. Trail, Sample #294	0.0521	215	0.41	0.259	31	n.d.	n.d.	0.72	2.71	36.9

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)									
	S%	Cl	K%	Ca%	Ti	V	Cr	Ni	Cu	Zn
<i>Aleatoria sarmentosa</i> , Mac Gruder G.S. Trail, Sample #295	0.0178	128	0.163	0.157	1.33	n.d.	n.d.	n.d.	0.61	16.9
<i>Letharia vulpina</i> , Mac Gruder G.S. Trail Sample #296	0.0346	172	0.211	0.23	28.7	n.d.	n.d.	n.d.	0.84	21.3
<i>Letharia vulpina</i> , U.S.F.S. Road #108, Sample #300	0.0478	210	0.15	0.349	73.7	3.25	2.21	0.575	1.41	27.1
<i>Lobaria pulmonaria</i> , White Cap Creek Trail, Sample #318	0.0598	3.72	0.398	0.0752	71.1	n.d.	2.72	0.79	3.07	8.42
<i>Letharia vulpina</i> , White Cap Creek Trail, Sample #319	0.0451	177	0.237	0.211	59.7	n.d.	n.d.	0.61	1.78	26.6

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)								
	Pb	Mn	Fe	Co	As	Se	Br	Rb	Sr
<i>Umbilicaria vellea</i> , Bear Creek Pass, Sample #152	41	75	2400	n.d.	n.d.	n.d.	15	18	18
<i>Letharia vulpina</i> , Carlton Lakes, Sample #156	29	71	470	n.d.	n.d.	n.d.	n.d.	22	n.d.
<i>Parmelia saxatilis</i> , Nez Perce Pass, Sample #157	54	740	8700	n.d.	n.d.	n.d.	43	62	95
<i>Umbilicaria vellea</i> , St. Mary's Peak, Sample #160	n.d.	29	1800	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
<i>Alectoria sarmentosa</i> , Race Creek Trail, Sample #199	2.9	46	58	2.3	n.d.	n.d.	3.3	n.d.	15
<i>Lobaria pulmonaria</i> , Race Creek Trail, Sample #200	n.d.	20	570	0.44	n.d.	n.d.	6.2	2.5	10
<i>Lobaria pulmonaria</i> , Race Creek Trail, Sample #201	2.9	47	1400	3.3	0.86	n.d.	6.7	4.3	33
<i>Letharia vulpina</i> , Fog Mountain Saddle, Sample #202	3.8	120	240	1.1	n.d.	n.d.	4.2	3.9	13
<i>Umbilicaria hyperborea</i> , Fog Mountain Saddle, Sample #203	34	49	2400	5.4	n.d.	n.d.	6.1	6.8	16
<i>Letharia vulpina</i> , USFS Road #290, Sample #204	5.1	130	570	1.5	0.57	n.d.	6.4	n.d.	23
<i>Alectoria sarmentosa</i> , Indian Hill, Sample #205	1.9	145	90	n.d.	n.d.	n.d.	3.8	1.5	8
<i>Umbilicaria vellea</i> , Indian Hill, Sample #206	11	65	3300	n.d.	2	n.d.	8.2	15	25

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)								
	Pb	Mn	Fe	Co	As	Se	Br	Rb	Sr
<i>Bryoria fremontii</i> , Walton Lakes. Sample #268	4.14	124	495	n.d.	1	n.d.	5.21	8.34	13.8
<i>Letharia vulpina</i> , Walton Lakes. Sample #269	n.d.	47.2	525	n.d.	n.d.	n.d.	3.74	6.15	7.75
<i>Umbilicaria hyperborea</i> , Walton Lakes. Sample #271	33.6	54.8	3480	n.d.	2.74	0.97	2.19	15.2	27
<i>Lobaria pulmonaria</i> , Eagle Mt. Trailhead. Sample #273	2.86	29.6	698	4.54	n.d.	n.d.	3.26	4.16	24.1
<i>Lobaria pulmonaria</i> , Wilderness Gateway, Sample #274	n.d.	26.1	1330	n.d.	n.d.	n.d.	4.48	5.73	51.1
<i>Umbilicaria polyphylla</i> , Wild. Gateway, Sample #275	25.7	39.9	2970	n.d.	n.d.	n.d.	3.38	8.54	34.8
<i>Usnea subfloridana</i> , Wilderness Gateway, Sample #279	n.d.	165	481	n.d.	1.22	0.88	6.09	n.d.	54.5
<i>Xanthoparmelia cumberlandia</i> , Wild. Gateway, Sample #280	10.3	187	7440	n.d.	1.41	n.d.	8.4	16.4	78.9
<i>Alectoria sarmentosa</i> , Fish Hatchery, Sample #281	13.3	20	83.5	n.d.	n.d.	n.d.	1.4	n.d.	18.1
<i>Lobaria pulmonaria</i> , Fish Hatchery, Sample #283	n.d.	32.9	785	5.1	n.d.	n.d.	3.18	5.01	15.7
<i>Bryoria fremontii</i> , Mac Gruder G.S. Trail, Sample #294	5.86	138	511	n.d.	1.28	n.d.	4.11	3.76	19.7
<i>Alectoria sarmentosa</i> , Mac Gruder G.S. Trail, Sample #295	n.d.	109	93.6	n.d.	0.56	n.d.	1.71	n.d.	23.1

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)								
	Pb	Mn	Fe	Co	As	Se	Br	Rb	Sr
<i>Letharia vulpina</i> , Mac Gruder G.S. Trail, Sample #296	n.d.	90.4	195	n.d.	n.d.	n.d.	1.77	n.d.	17.7
<i>Letharia vulpina</i> , U.S.F.S. Road #468, Sample #300	8.72	192	505	n.d.	1.49	n.d.	8.87	4.02	14.1
<i>Lobaria pulmonaria</i> , White Cap Creek Trail, Sample #318	n.d.	58.8	568	n.d.	n.d.	n.d.	3.43	5.4	10.1
<i>Letharia vulpina</i> , White Cap Creek Trail, Sample #319	n.d.	61.8	451	n.d.	1.17	n.d.	3.16	n.d.	14.7

Fig. 2 Lichen Biomonitoring Program and Baseline

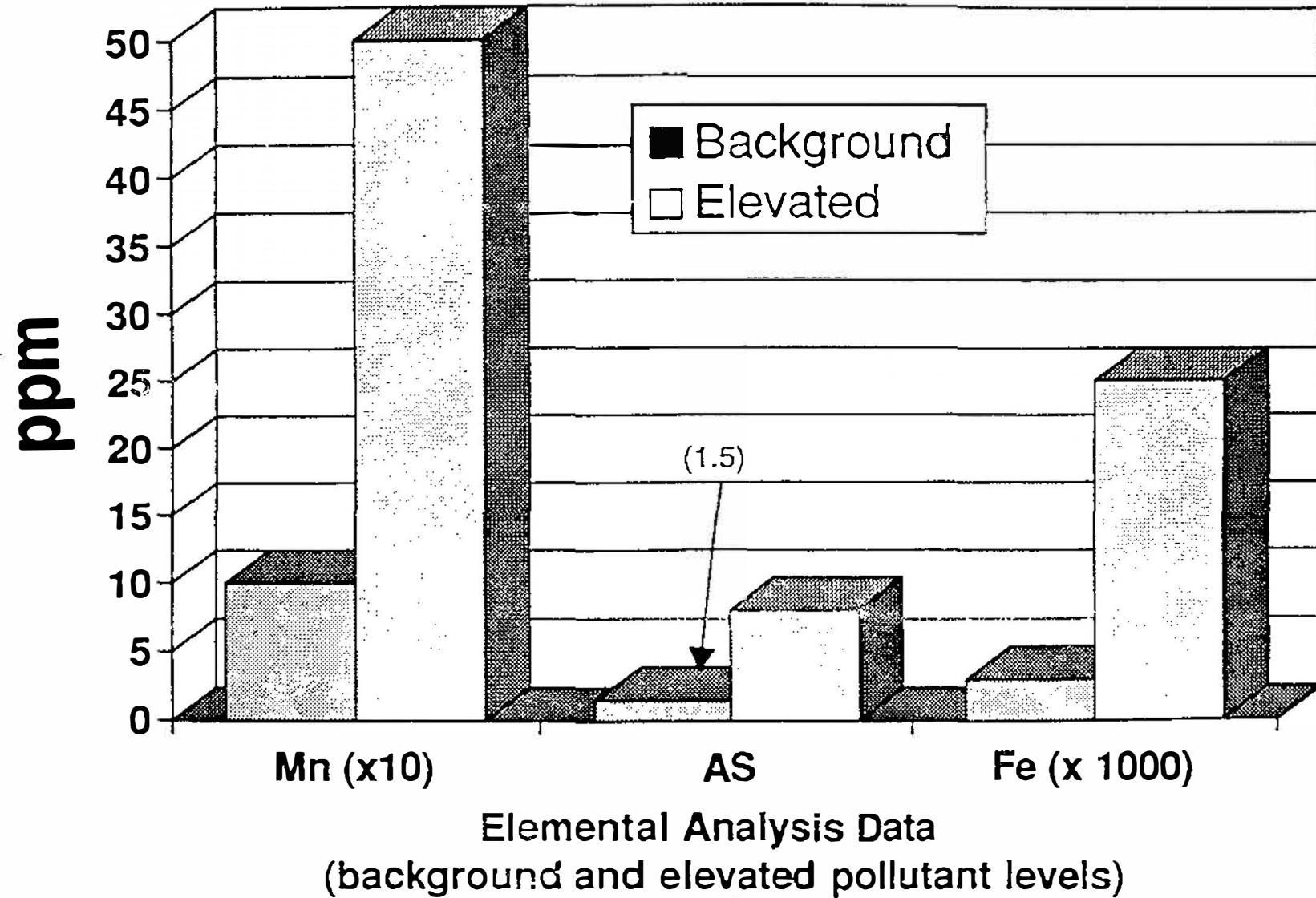
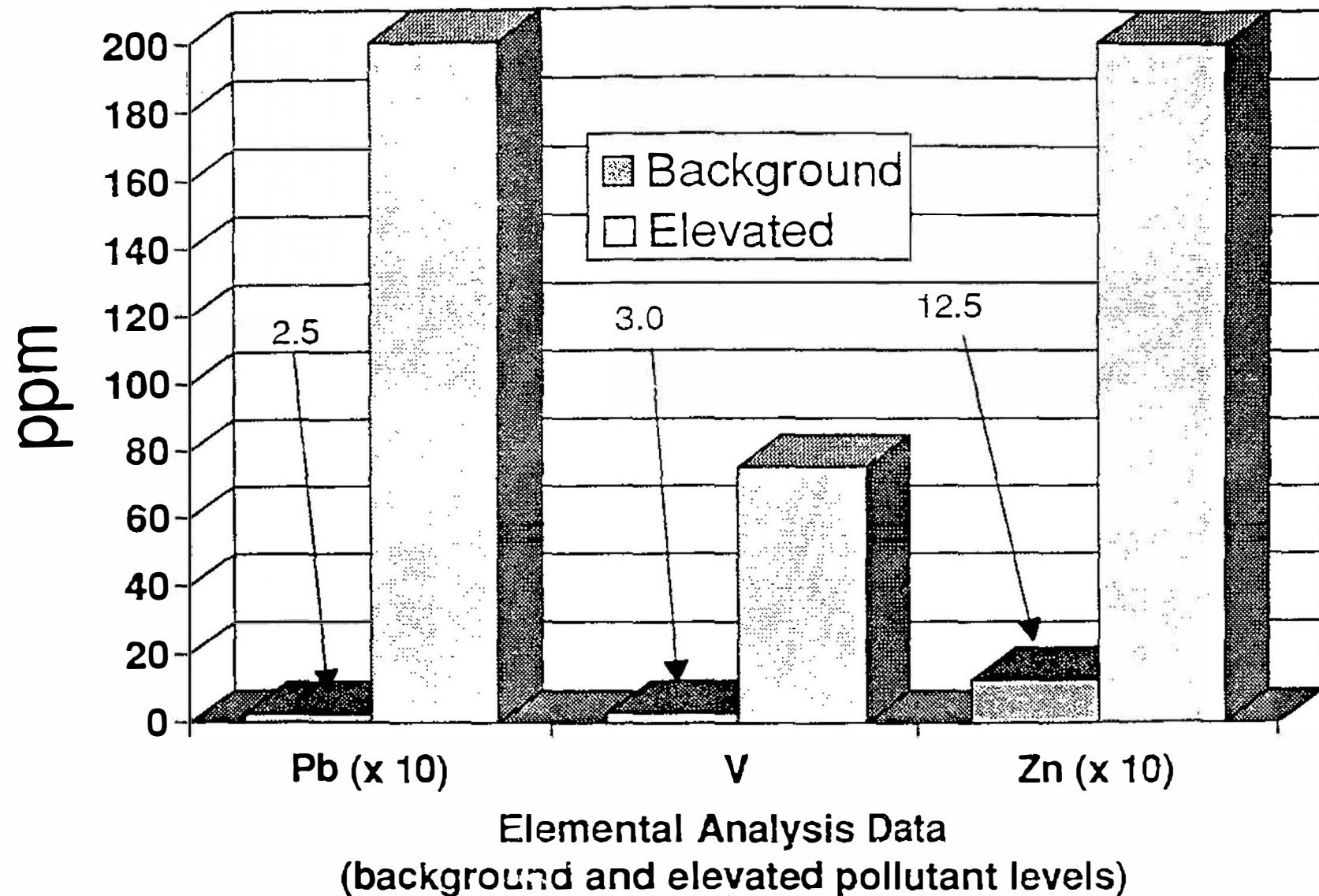


Fig. 2 cont. Lichen Biomonitoring Program and Baseline



with a 0.27 mm² pinhole (2.8% of detector area). The Mylar was backed with 8.5 mg/cm² beryllium foil. A 98 mg/cm² Mylar absorber was also used.

To insure adequate quality control, samples of NIST SRM 1571 orchard leaves, and other standards were also prepared and analyzed using the same procedures.

RESULTS AND RECOMMENDATIONS

LICHEN MATERIAL COLLECTED FOR ELEMENTAL ANALYSES:

A total of 47 samples including 10 species from 4 substrates were collected for elemental analyses. Analyses of at least one species from each reference site were performed using Proton Induced X-Ray Emission (PIXE) technology. Below is a list of the elemental analysis samples by sample number, species, substrate, and collection site (the first number represents the storage drawer and the second number indicates the bag number). All specimens are stored in Hubco cloth bags in the elemental analysis collection at the Herbarium of Nonvascular Cryptogams at Brigham Young University. The "*" designates those samples which have been analyzed for elemental concentrations. All sensitive indicator species are listed by reference site in Appendix A.

Sample #	Taxa	Substrate	Reference site
19-152*	<i>Umbilicaria vellea</i>	Rock	1
19-153	<i>Letharia vulpina</i>	Bark	3
19-154	<i>Letharia vulpina</i>	Bark	1
19-155	<i>Letharia vulpina</i>	Bark	2
19-156*	<i>Letharia vulpina</i>	Bark	5
20-157*	<i>Parmelia saxatilis</i>	Rock	4
20-158	<i>Letharia vulpina</i>	Bark	4
20-159	<i>Letharia vulpina</i>	Bark	6
20-160*	<i>Umbilicaria vellea</i>	Rock	6
20-161	<i>Letharia vulpina</i>	Lignum	6
24-199*	<i>Alectoria sarmentosa</i>	Bark	7
24-200*	<i>Lobaria pulmonaria</i>	Bark	7
24-201*	<i>Lobaria pulmonaria</i>	mossy rock	7
25-202*	<i>Letharia vulpina</i>	Bark	9
25-203*	<i>Umbilicaria hyperborea</i>	Rock	9
25-204*	<i>Letharia vulpina</i>	Bark	7
25-205*	<i>Alectoria sarmentosa</i>	Bark	8
25-206*	<i>Umbilicaria vellea</i>	Rock	8
32-268*	<i>Bryoria fremontii</i>	Bark	13
32-269*	<i>Letharia vulpina</i>	Bark	13
32-270	<i>Letharia columbiana</i>	Lignum	13
32-271*	<i>Umbilicaria hyperborea</i>	rock	13
32-272	<i>Letharia vulpina</i>	Lignum	13
32-273*	<i>Lobaria pulmonaria</i>	Bark	14
32-274*	<i>Lobaria pulmonaria</i>	Bark	14
32-275*	<i>Umbilicaria polyphylla</i>	Rock	14
32-276	<i>Bryoria fremontii</i>	Bark	14
32-277	<i>Umbilicaria vellea</i>	Rock	14
32-278	<i>Alectoria sarmentosa</i>	Bark	14
32-279*	<i>Usnea subfloridana</i>	Bark	14
32-280*	<i>Xanthoparmelia cumberlandia</i>	Rock	14
33-281*	<i>Alectoria sarmentosa</i>	Bark	15

Sample#	Taxa	Substrate	Reference site
33-282	<i>Bryoria fremontii</i>	Bark	15
33-283*	<i>Lobaria pulmonaria</i>	Bark	15
34-294*	<i>Bryoria fremontii</i>	Bark	11
34-295*	<i>Alectoria sarmentosa</i>	Bark	11
34-296*	<i>Letharia vulpina</i>	Bark	11
34-297	<i>Umbilicaria vellea</i>	Rock	11
34-298	<i>Bryoria fremontii</i>	Bark	12
34-299	<i>Umbilicaria hyperborea</i>	Rock	12
34-300*	<i>Letharia vulpina</i>	Lignum	12
34-301	<i>Umbilicaria vellea</i>	Rock	12
35-316	<i>Umbilicaria vellea</i>	Rock	10
35-317	<i>Bryoria fremontii</i>	Bark	10
35-318*	<i>Lobaria pulmonaria</i>	Bark	10
35-319*	<i>Letharia vulpina</i>	Bark	10
35-320	<i>Alectoria sarmentosa</i>	Bark	10

CHECKLIST OF LICHEN SPECIES FROM SELECTED SITES IN THE SELWAY-BITTERROOT WILDERNESS AREA, MONTANA

Acarospora chlorophana (Wahlenb. ex Ach.) Massal.

Growth form: Crustose with effigurate margins

Substrate: rock

Site(s): St. Mary's Peak, Nez Perce Pass, Carlton Ridge

Relative abundance: locally common

Pollution sensitivity: sensitive to sulfur dioxide (Hale 1982)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21831, BRY C-23312, BRY C-23387

Ahtiana sphaerospora (Müll. Arg.) Goward

Growth form: Foliose

Substrate: White Bark Pine

Site(s): Near Carlton Lake, along U.S.F.S. Road #468

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23388, BRY C-26388

Alectoria imshaugii Brodo & D. Hawksw.

Growth form: Fruticose

Substrate: Subalpine Fir, Ponderosa Pine, Douglas Fir

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, vicinity of Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, along MaGruder Guard Station Trail

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23313, BRY C-23452, BRY C-26287, BRY C-26362, BRY C-26458, BRY C-28665

Alectoria sarmentosa (Ach.) Ach.

Growth form: Fruticose

Substrate: Subalpine Fir, lignum, Hemlock, Douglas Fir, Ponderosa Pine,

Amelanchier sp., Thuja plicata, soil, Alnus sp.

Site(s): Nez Perce Pass, Carlton Ridge, Mormon Ridge Trail, South Fork Lost Horse Creek, Race Creek Trail, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, Below Indian Hill, vicinity of White Cap Creek Trail, Wilderness Gateway-Eagle Mountain Trailhead, vicinity of Walton Lakes, along MaGruder Guard Station Trail, vicinity of Fish Hatchery

Relative abundance: common

Pollution sensitivity: sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23314, BRY C-23389, BRY C-23390, BRY C-23453, BRY C-26275, BRY C-26341, BRY C-26455, BRY C-26474, BRY C-26504, BRY C-26578, BRY C-26606, BRY C-26617, BRY C-26622, BRY C-28577, BRY C-28599, BRY C-28614, BRY C-28644, BRY C-28664, BRY C-28684, BRY C-28986

Arthrorhaphis alpina (Schraerer) R. Sant.

Growth form: Crustose

Substrate: soil

Site(s): St. Mary's Peak

Relative abundance: rare

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21893

Aspicilia aquatica Körber

Growth form: Crustose

Substrate: rocks submerged in creek

Site(s): vicinity of White Cap Creek Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26530

Aspicilia cinerea (L.) Körber

Growth form: Crustose

Substrate: rock

Site(s): Nez Perce Pass, Carlton Ridge, South Fork Lost Horse Creek

Relative abundance: locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23315, BRY C-23391, BRY C-23454

Aspicilia desertorum (Krempelh.) Mereschk.

Growth form: Crustose

Substrate: rock

Site(s): along MaGruder Guard Station Trail

Relative abundance: rare to common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26358

Baeomyces rufus (Huds.) Rebent.

Growth form: Crustose

Substrate: soil

Site(s): vicinity of Fog Mountain Saddle, vicinity of Fish Hatchery

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26713, BRY C-28979

Bellemerea alpina (Sommerf.) Clauz. & Roux

Growth form: Crustose

Substrate: rock

Site(s): Nez Perce Pass, Carlton Ridge, Bear Creek Pass, along U.S.F.S. Road #468

Relative abundance: common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23316, BRY C-23392,
BRY C-23455, BRY C-26549

Bellemerea cinereorufescens (Ach.) Clauz. & Roux

Growth form: Crustose

Substrate: rock

Site(s): Nez Perce Pass, South Fork Lost Horse Creek, along MaGruder Guard
Station Trail

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23317, BRY C-23456,
BRY C-26359

Biatora vernalis (L.) Fr.

Growth form: Crustose

Substrate: Douglas Fir

Site(s): Nez Perce Pass

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23318

Brodoa oroarctica (Krog) Goward

Growth form: Foliose

Substrate: soil, detritus, rock

Site(s): St. Mary's Peak, vicinity of Indian Hill

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-21818, BRY C-21820,
BRY C-28679

Bryonora castanea (Hepp) Poelt

Growth form: Crustose

Substrate: soil, detritus

Site(s): St. Mary's Peak

Relative abundance: rare to locally common

Pollution sensitivity: Unknown

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-22070

Bryoria abbreviata (Müll. Arg.) Brodo & D. Hawksw.

Growth form: Fruticose

Substrate: White Bark Pine, Subalpine Fir, Lodgepole Pine, Douglas Fir, Engelmann Spruce

Site(s): Nez Perce Pass, Carlton Ridge, vicinity of Fog Mountain Saddle, vicinity of Indian Hill, vicinity of Walton Lakes, along U.S.F.S. Road #468

Relative abundance: rare to locally common

Pollution sensitivity: sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-23319, BRY C-23393,
BRY C-26383, BRY C-26412, BRY C-26422, BRY C-26424, BRY C-28672,
BRY C-28674, BRY C-28973, BRY C-28997

Bryoria capillaris (Ach.) Brodo & D. Hawksw.

Growth form: Fruticose

Substrate: Subalpine Fir, Amelanchier sp., Douglas Fir, Thuja plicata

Site(s): vicinity of Fog Mountain Saddle, Wilderness Gateway-Eagle Mountain Trailhead

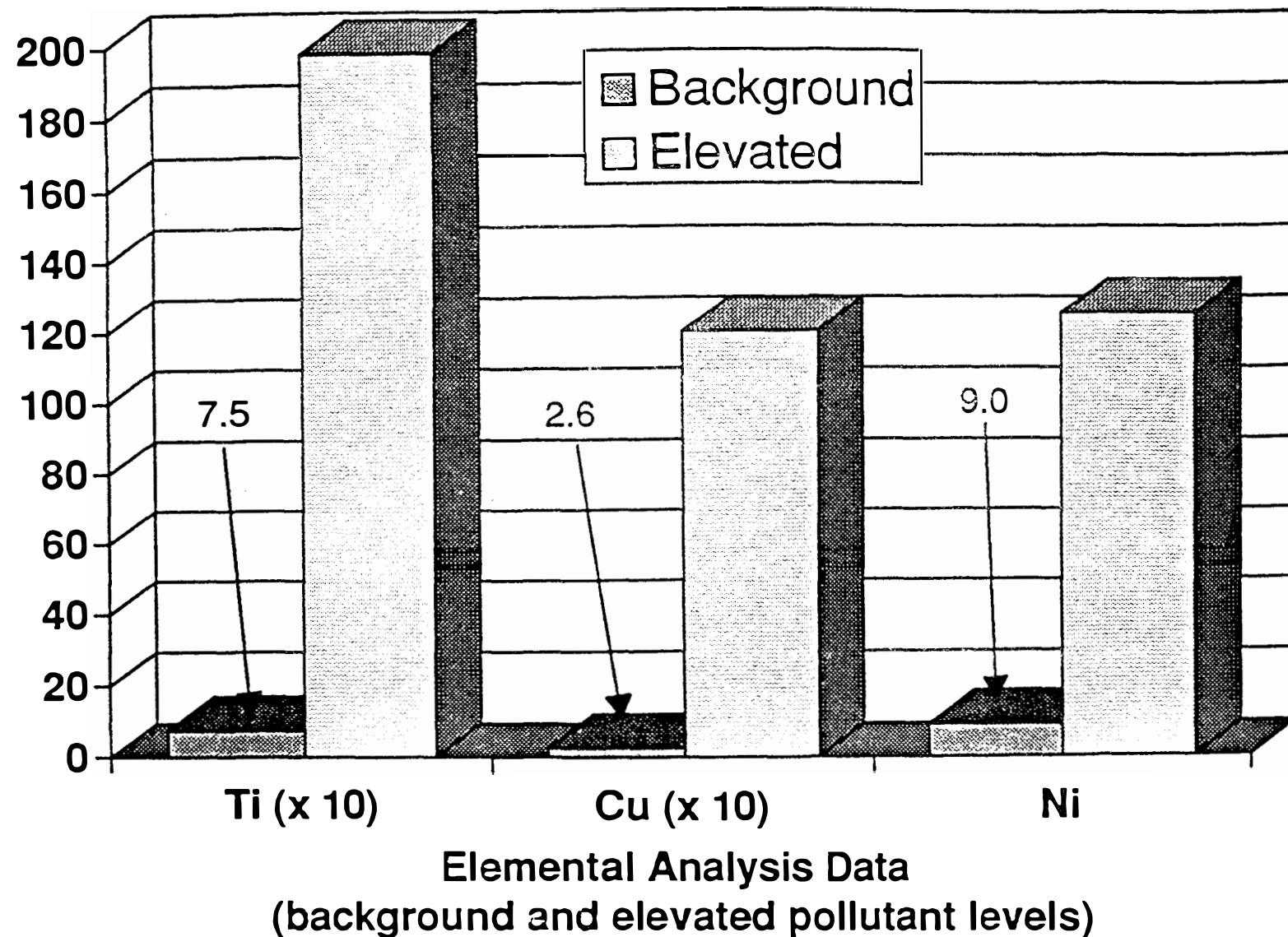
Relative abundance: locally common

Pollution sensitivity: sensitive to sulfur dioxide; sensitive to fluoride (Ryan 1990)

Comments: none

Deposition of specimens: BYU Herbarium: BRY C-26490, BRY C-26603,
BRY C-28975, BRY C-28983

Fig. 2 cont. Lichen Biomonitoring Program and Baseline



information about the lichen flora as well as additional baseline information about the status of sensitive indicator species.

2. Generally, re-evaluation of sensitive indicator species should be performed every 5 to 8 years, depending on significant changes in either local or regional air pollution patterns. The development of new air pollution sources in close proximity to the wilderness area would also be a significant factor in determining the timing of followup surveys.
3. Re-evaluation of the lichen flora at existing reference sites is generally unnecessary, unless sensitive indicator species begin to show either high levels of pollutant elements or significant changes in relative abundance.
4. Eventually, the additional sensitive indicator material should be analyzed in order to strengthen the baseline.
5. Concentrations of nickel in *Letharia vulpina* samples from Carlton Lakes should be carefully reviewed in subsequent surveys.
6. Just to be cautious, concentrations of nickel, copper and zinc in *Alectoria sarmentosa* samples collected near the fish hatchery along U.S. Forest Service Road #362, should also be carefully reviewed in follow-up surveys.

BIBLIOGRAPHY

Duflou, H., W. Maenhaut, and J. DeReuck. 1987. Application of PIXE analysis to the study of regional distribution of trace elements in normal human brain tissue. *Biological Trace Element Research* 13:1.

Fields, R.D. and L.L. St. Clair. 1984. A comparison of methods for evaluating SO₂ impact of selected lichen species: *Parmelia chlorochroa*, *Collema polycarpon*, and *Lecanora muralis*. *The Bryologist* 87: 297-301.

Fields, R.D. and L.L. St. Clair. 1984. The effects of SO₂ on photosynthesis and carbohydrate transfer in the two lichens: *Collema polycarpon* and *Parmelia chlorochroa*. *American Journal of Botany* 71: 986-998.

Hale, M.E. 1983. *The Biology of Lichens*. pp. 1-190. Arnold Publishers, London.

Lawrey, J.D. and M.E. Hale. 1981. Retrospective study of lichen lead accumulation in the northeastern United States. *The Bryologist* 84: 449-456.

Richardson, D.H.S. 1992. Pollution monitoring with lichens. *Naturalist Handbook* #19, The Richmond Publishing Co. LTD, Sough, England. 76pp.

Rope, S.K. and L.C. Pearson. 1990. Lichens as air pollution biomonitorors in a semiarid environment in Idaho. *The Bryologist* 93: 50-61.

Rushforth, S.R., L.L. St. Clair, J.D. Brotherson, and G.T. Nebeker. 1982. Lichen community structure in Zion National Park. *The Bryologist* 85: 185-192.

Ryan, B.D., T.H. Nash, and W. Davis. 1990. Lichens and air quality in the Mount Baldy Wilderness Area. U.S. Forest Service Technical Report.

St. Clair, L.L. 1989. Report concerning establishment of a lichen biomonitoring program and baseline for the Jarbidge Wilderness Area, Humboldt National Forest, Nevada. U.S. Forest Service Technical Report. 15pp.

Schutte, J.A. 1977. Chromium in two corticolous lichens from Ohio and West Virginia. *The Bryologist* 80: 279-283.

Wetmore, C.M. 1987. Lichens and air quality in Saguaro National Monument. Technical report submitted to the National Park Service, CX 001-2-0034.

Wetmore, C.M. 1989. Lichens and air quality on Cuyahoga National Recreation Area, Ohio. *The Bryologist* 92: 273-281.

APPENDIX A

LIST OF POLLUTION SENSITIVE INDICATOR SPECIES BY REFERENCE SITE:

Carlton Ridge:

Acarospora chlorophana (sensitive to sulfur dioxide)
Alectoria sarmentosa (sensitive to ozone)
Bryoria abbreviata (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Lecanora saligna (intermediately sensitive to sulfur dioxide)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Parmelia saxatilis (intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Platismatia glauca (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Pseudephebe minuscula (intermediately sensitive to ozone)
Rhizocarpon geographicum (sensitive to fluoride)
Rhizoplaca chrysolutea (sensitive to sulfur dioxide; sensitive to nitrous oxides and PAN)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Tuckermannopsis merrillii (sensitive to intermediately sensitive to ozone)
Umbilicaria polyphylla (intermediately sensitive to sulfur dioxide)
Xanthoria fallax (sensitive to intermediately sensitive to sulfur dioxide; sensitive to nitrous oxides and PAN)

vicinity of Fish Hatchery (along U.S. Forest Service Road #362):

Alectoria sarmentosa (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Cladonia multiformis (intermediately sensitive to sulfur dioxide)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Hypogymnia tubulosa (intermediately sensitive to sulfur dioxide)
Lobaria pulmonaria (sensitive to sulfur dioxide)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Platismatia glauca (intermediately sensitive to sulfur dioxide)

vicinity of Fog Mountain Saddle:

Alectoria sarmentosa (sensitive to ozone)
Bryoria abbreviata (sensitive to ozone)
Bryoria capillaris (sensitive to sulfur dioxide; sensitive to fluoride)
Bryoria fremontii (sensitive to ozone)
Bryoria fuscescens (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Evernia prunastri (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Lobaria pulmonaria (sensitive to sulfur dioxide)
Melanelia exasperanula (intermediately sensitive to sulfur dioxide)
Melanelia subolivacea (intermediately sensitive to ozone)
Parmelia sulcata (sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide)
Platismatia glauca (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Rhizocarpon geographicum (sensitive to fluoride)
Rhizoplaca chrysoleuca (sensitive to sulfur dioxide; sensitive to nitrous oxides and PAN)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Tuckermannopsis chlorophylla (sensitive to sulfur dioxide)
Tuckermannopsis merrillii (sensitive to intermediately sensitive to ozone)
Umbilicaria polyphylla (intermediately sensitive to sulfur dioxide)
Usnea subfloridana (sensitive to intermediately sensitive to sulfur dioxide)

Vicinity of Indian Hill:

Alectoria sarmentosa (sensitive to ozone)
Bryoria abbreviata (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Evernia prunastri (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Parmelia saxatilis (intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (intermediately sensitive to sulfur dioxide)
Platismatia glauca (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Tuckermannopsis chlorophylla (sensitive to sulfur dioxide)
Umbilicaria polyphylla (intermediately sensitive to sulfur dioxide)
Usnea hirta (sensitive to intermediately sensitive to sulfur dioxide)

Lost Horse Canyon (combined for all sites in Lost Horse Canyon):

Alectoria sarmentosa (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Bryoria fuscescens (intermediately sensitive to sulfur dioxide)
Calicium viride (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Cladonia coniocraea (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Cladonia gracilis (intermediately sensitive to sulfur dioxide)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)

Lost Horse Canyon cont.:

Letharia vulpina (intermediately sensitive to ozone)
Ochrolechia androgyna (sensitive to sulfur dioxide)
Parmelia saxatilis (intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Parmelia sulcata (sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Physconia detersa (sensitive to intermediately sensitive to sulfur dioxide)
Platismatia glauca (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Rhizocarpon geographicum (sensitive to fluoride)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Tuckermannopsis chlorophylla (sensitive to sulfur dioxide)
Tuckermannopsis merrillii (sensitive to intermediately sensitive to ozone)
Umbilicaria polyphylla (intermediately sensitive to sulfur dioxide)
Usnea subfloridana (sensitive to intermediately sensitive to sulfur dioxide)
Xanthoria candelaria (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Xanthoria fallax (sensitive to intermediately sensitive to sulfur dioxide; sensitive to nitrous oxides and PAN)

along MaGruder Guard Station Trail (U.S. Forest Service Trail #4):

Alectoria sarmentosa (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Calicium viride (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Letharia vulpina (intermediately sensitive to ozone)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)

Nez Perce Pass:

Acarospora chlorophana (sensitive to sulfur dioxide)
Alectoria sarmentosa (sensitive to ozone)
Bryoria abbreviata (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Bryoria fuscescens (intermediately sensitive to sulfur dioxide)
Cladonia coniocrea (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Cladonia gracilis (intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Parmelia saxatilis (intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Parmelia sulcata (sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Peltigera collina (sensitive to ozone)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physconia detersa (sensitive to intermediately sensitive to sulfur dioxide)
Rhizocarpon geographicum (sensitive to fluoride)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)

Race Creek Trail:

Alectoria sarmentosa (sensitive to ozone)
Bryoria fuscescens (intermediately sensitive to sulfur dioxide)
Calicium viride (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Candelaria concolor (sensitive to intermediately sensitive to sulfur dioxide)
Cladonia bellidiflora (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Evernia prunastri (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Lobaria oregana (sensitive to sulfur dioxide)
Lobaria pulmonaria (sensitive to sulfur dioxide)
Melanelia subaurifera (sensitive to ozone; sensitive to NO_xPAN)
Melanelia subolivarea (intermediately sensitive to ozone)
Parmelia saxatilis (intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Parmelia sulcata (sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Peltigera canina (sensitive to ozone)
Peltigera collina (sensitive to ozone)
Physcia stellaris (intermediately sensitive to sulfur dioxide)
Platismatia glauca (intermediately sensitive to sulfur dioxide; sensitive to ozone)
Tuckermannopsis chlorophylla (sensitive to sulfur dioxide)
Xanthoparmelia cumberlandia (sensitive to sulfur dioxide)
Xanthoria candelaria (intermediately sensitive to sulfur dioxide; sensitive to ozone)

St. Mary's Peak:

Acarospora chlorophana (sensitive to sulfur dioxide)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Parmelia sulcata (sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Pseudephebe minuscula (intermediately sensitive to ozone)
Rhizocarpon geographicum (sensitive to fluoride)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)

along U.S.F.S. Road #468 (between "Observation Point" and Salmon Base Camp):

Bryoria abbreviata (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)

vicinity of Walton Lakes (along U.S. Forest Service Trail #79):

Alectoria sarmentosa (sensitive to ozone)
Bryoria abbreviata (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Bryoria fuscescens (intermediately sensitive to sulfur dioxide)
Cladonia coniocraea (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Lecanora saligna (intermediately sensitive to ozone)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (intermediately sensitive to sulfur dioxide)
Peltigera didactyla (sensitive to ozone)
Pseudephebe pubescens (intermediately sensitive to ozone)

along White Cap Creek Trail (U.S. Forest Service Trail #24):

Alectoria sarmentosa (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Calicium viride (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Evernia prunastri (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Lobaria pulmonaria (sensitive to sulfur dioxide)
Parmelia saxatilis (intermediately sensitive to sulfur dioxide)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Peltigera collina (sensitive to ozone)
Platismatia glauca (intermediately sensitive to sulfur dioxide)
Tuckermannopsis canadensis (sensitive to ozone)
Tuckermannopsis chlorophylla (sensitive to sulfur dioxide)
Xanthoria polycarpa (intermediately sensitive to sulfur dioxide)

Wilderness Gateway-Eagle Mountain Trailhead:

Alectoria sarmentosa (sensitive to ozone)
Bryoria capillaris (sensitive to flouride; sensitive to sulfur dioxide)
Bryoria fremontii (sensitive to ozone)
Bryoria fuscescens (intermediately sensitive to sulfur dioxide)
Cladonia bellidiflora (intermediately sensitive to sulfur dioxide)
Cladonia coniocraea (intermediately sensitive to sulfur dioxide)
Evernia prunastri (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Hypogymnia physodes (intermediately sensitive to sulfur dioxide)
Letharia vulpina (intermediately sensitive to ozone)
Lobaria pulmonaria (sensitive to sulfur dioxide)
Melanelia subaurifera (sensitive to ozone; sensitive to NO_x/PAN)
Parmelia sulcata (sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (intermediately sensitive to sulfur dioxide)
Platismatia glauca (intermediately sensitive to sulfur dioxide)
Tuckermannopsis canadensis (sensitive to ozone)

Wilderness Gateway-Eagle Mountain Trailhead cont.:

Tuckermannopsis chlorophylla (sensitive to sulfur dioxide)

Tuckermannopsis merrillii (sensitive to intermediately sensitive to ozone)

Umbilicaria polyphylla (intermediately sensitive to sulfur dioxide)

Usnea subfloridana (sensitive to intermediately sensitive to sulfur dioxide)

Xanthoparmelia cumberlandia (sensitive to sulfur dioxide)